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PITA Project: Policy Influences on Technology for Agriculture: Chemicals, Biotechnology and Seeds

Monsanto monograph¹

Annex C11

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¹Joanna Chataway and ²Joyce Tait

**¹Centre for Technology Strategy
Open University
United Kingdom**

**²Scottish Universities Policy Research and Advice Network (SUPRA)
The University of Edinburgh
United Kingdom**

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¹ This report has been compiled by Joanna Chataway on the basis of interviews (carried out by Joanna Chataway and Joyce Tait), the PITA company dossier and a number of published reports. Cognitive maps have been developed from interviews. The Spanish team carried out interviews with managers based in Spain. Interviews were carried out with 2 Senior managers in the UK, 3 Senior and 1 middle manager based in other parts of Europe and 1 senior manager based in the US.

Introduction to the PITA Project

Technological innovation in the agrochemical, biotechnology and seeds industries and in associated public sector research establishments (PSREs) has the potential to deliver more socially and environmentally sustainable farming systems and to improve the quality of life of citizens in Europe. This is particularly true of farms on the most fertile land. However, although policies developed in different areas may all aim to improve the quality of life, in practice, in their influence on company and PSRE strategies, they frequently counteract one another and so attenuate the desired effect.

Market-related factors also influence decision making in industry and PSREs, the most important for this project being the policies of food processors and distributors and also public attitudes and opinion, which often set more demanding standards than those of national governments and the EU.

The PITA project (see Project Structure) is developing an integrated analysis of policies and market-related factors relevant to the agrochemical, biotechnology and seeds sectors. The core of the project is an investigation of the impact of these factors on the strategies and decision making of companies and PSREs and the downstream implications of these decisions on employment, international competitiveness and environmental benefits. The final outcome will be feedback of our conclusions to policy makers and company managers.

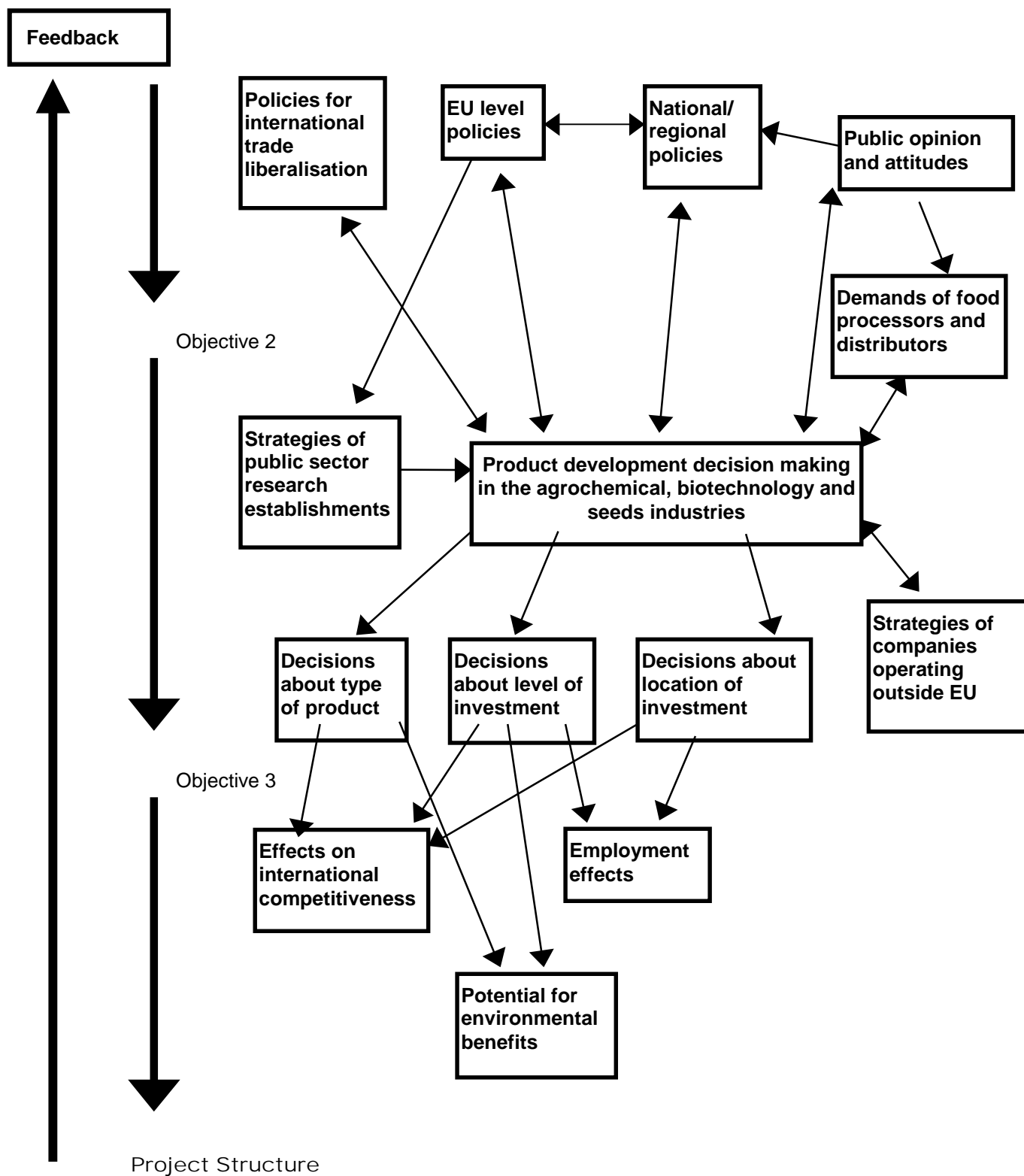
The range of policies and other influences studied includes:

- policies to stimulate innovation in the agrochemical, biotechnology and seeds industries;
- purchasing policies of food processors and distributors;
- policies for international trade liberalisation;
- policies for the regulation of industry and farming (for environmental protection and public health and safety, particularly for pesticides and biotechnology);
- agricultural and farming support policies, particularly for crop production;
- policies to promote environmental sustainability and wildlife biodiversity in arable farming areas;
- public opinion and attitudes.

The overall aim of the project is to contribute to the development of sustainable industrial and farming systems and an improved quality of life by encouraging the development and uptake of 'cleaner' technology for intensive agriculture. Its objectives are:

- to develop an integrated analysis of policies and market-related factors relevant to technological innovation in the agrochemical, biotechnology and seeds sectors, to study their interactions and to develop hypotheses about their impact on strategic decision making in industry and PSREs.
- to study the influence of policies and market-related factors on innovation strategies in the agrochemical, biotechnology and seeds industries and PSREs, and their impact on decisions about product development, levels of investment and location of investment.
- to study the outcomes of the industry decisions investigated under objective 2, in their effects on employment, on international competitiveness and on their potential to deliver environmental benefits.

Objective 1



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1. Introduction

Since the late 1980s Monsanto has wanted to be known for its prowess in biotechnology. This, above all, has been the major driver of its strategy for more than a decade. Current difficulties being experienced by the company mean that it perhaps risks infamy, rather than fame, as the executor of a strategy that has not succeeded.

Monsanto has had a rather narrow technological base in agricultural chemicals. A narrow product range, increasing technical difficulties in identifying new chemical based products, good profits from the products which it did have and a leadership team convinced that new technology would constitute the bedrock of future growth, lay the foundations of Monsanto's pursuit of leadership in biotechnology. Early on Monsanto identified itself as a Life Sciences company and put the new biotechnologies at the heart of its structure and plans. The company has succeeded in identifying itself with the new technology. However, at this juncture that signifies more problems than opportunities.

The recent merger with Pharmacia/Upjohn has not resolved difficulties for the company's agricultural division. The new leadership has indicated its intention of selling off the division after a poor stock-market response to initial plans to continue with an integrated 'life sciences' company approach.

The first section of this monograph provides some figures about Monsanto and some data about acquisitions and partnerships. Section 2 looks at Monsanto's current commercial profile in Agriculture. This section mainly draws on company documents and industry analysis. The middle sections of the document (sections 3 - 6) are based on interviews, company documents and industry analysis. These sections explain Monsanto's approach to innovation and R&D, the way in which its organisation and culture impact of innovation and R&D Decision making and the way in which policy is perceived to impact innovation and R&D plans. Quotes are all in italics. We have also used cognitive maps in this section (please see Appendix 1 for a brief explanation of the cognitive mapping technique). These maps are based on managers' thoughts and the way in which they linked ideas.

The concluding section is a reflection on Monsanto's approach and what it is that is distinctive about the company. This section is based on industry analysis and our own understanding.

1.1 Key Monsanto figures

Monsanto is a global company. It operates in three main divisions: pharmaceutical; nutrition and agriculture. Global figures covering all three divisions are as follows:

World accounts: geographical breakdown

Table 1 World Accounts².

\$bn	'93	'94	'95	'96	'97	'98
Net sales incl. chemicals	7.90	8.27	8.96	9.26		
Net sales excl. chemicals	3.68	4.6*	5.4*	6.3*	7.5	8.6
<i>Net sales Europe & Africa</i>	1.56				1.4	1.6
Operating Profit (before exceptional items)**	0.81	0.92	0.98	0.59	0.3	-0.25
Net profit/loss					0.9	0.6
R&D expenses			0.56	0.64	0.94	1.26
Assets world	8.64	8.89	10.6		10.7	16.72
Assets Europe & Africa					1.8	2.80
Employees		29,400	28,500	28,000	21,900	31,800

Sales: 'Europe & Africa' accounted for approx. \$1.4bn/\$7.5bn – 19% of world sales in 1997

Assets: 'Europe & Africa' accounted for approx. \$1.8bn/\$10.7bn – 17% of world assets in 1997.

'Agriculture' business unit

Monsanto's accounts treat agriculture as agrochemicals and seeds combined. It is extremely difficult to get financial figures which disaggregate the agriculture sector. The following figures come from annual reports.

Agricultural/total company ratios

Sales: agricultural products accounted for \$3.1bn/\$7.5bn – 42% of total world sales in 1997 (Nutrition and Consumer products; 20%, Pharmaceuticals, 32%; Corporate and other 6%.)

Assets: agricultural assets accounted for \$4.5bn/\$10.8bn – 42% of total world assets in 1997

²* For the sake of comparability with subsequent years, the figures exclude income (approx. \$3bn) from industrial chemicals – a unit which was sold off in 1997.

** Rather than 'operating profit', this figure is 'operating income' = net sales - (cost of goods + expenses).

Table 2 Agricultural Division Accounts³

\$bn	'93	'94	'95	'96	'97	'98
Net sales	1.9	2.22	2.47	2.5	3.1	4.0
<i>Net sales Europe & Africa</i>	<i>0.4?</i>	<i>0.3</i>	<i>0.4</i>	<i>0.5</i>	<i>0.5</i>	
Operating Profit (before exceptional items)**	0.48	0.47	0.51	0.54	0.11	0.8
Net profit						1.1
R&D expenses						
Assets	2.1	2.4	2.6	3.0	4.5	10.3

Agricultural products: geographical breakdown of sales (AR 1997, p.36, chart)

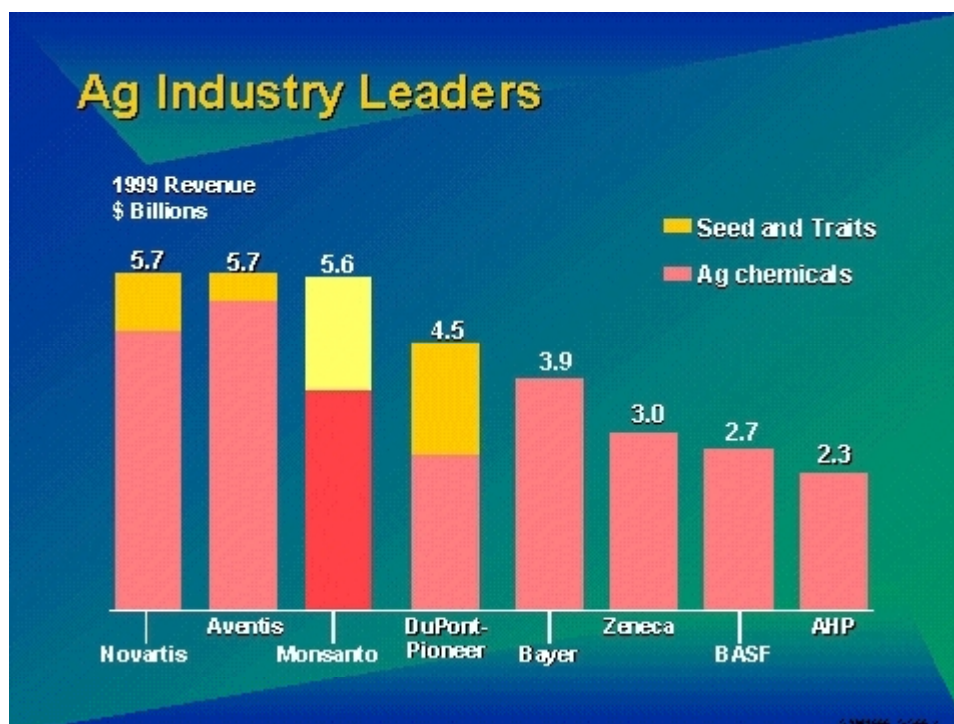
1996: 'Europe & Africa' accounted for approx. \$0.5bn/\$2.6bn – 20% of agricultural world sales in 1996

1997: 'Europe & Africa' accounted for approx. \$0.5bn/\$3.2bn – 16% of agricultural world sales in 1997 (i.e. sales did not increase there as the world total increased).

More disaggregated figures relating to the breakdown of chemicals, seeds and traits do not seem to be in the public domain. The scale of Monsanto's investment in seeds and biotechnology can be measured, albeit less accurately, from other company sources. The following graph comes from a presentation by company President Henrik Verfaillie (Verfaillie, 1999). It shows the ag-chem/seeds and traits profile of Monsanto's revenue as compared with other competitors.

^{3**} Rather than 'operating profit', this figure is 'operating income' = net sales - (cost of goods + expenses).

Figure 1 Ag Industry Leaders



The proportion of Monsanto's share of revenue from seeds/traits is matched only by Dupont/Pioneer. Investment in seed companies is discussed later in the section on innovation strategies. R&D spending is also discussed in that section. More information about the performance of Monsanto's chemical and biotechnology based products is provided in the next section.

Monsanto has pursued an aggressive acquisitions policy. This is discussed in detail later in the report. It has also formed an extensive web of partnerships both with companies that it has acquired, setting up new ventures and with other companies. It has pursued this strategy to fulfill both marketing and R&D objectives. The following provide some detail about research partnerships and subsidiaries.

Box 1. Research agreements

Monsanto has numerous research agreements for genomics, especially for pharmaceuticals. Monsanto has always pursued a strategy of creating research partnerships as a way to build capacity (Joly, 1999). Partnerships are thought of as important for building research capabilities.

This list however includes only those relevant to agriculture.

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Title	Name of partners	Type of agreement	Amount	Duration	priorities
Arqule		?	\$12m+	1997-2002	chemicals + crop-protection agents
Renessen	Cargill	?	\$200m		animal feed and processing traits
	IBM	Genomics			
Mendel Biotechnology	Empresas La Modernas	Genomics		1998-?	
Cereon Genomics LLC	Millennium Pharmaceuticals	Genomics	\$218m	1998-?	plants
Incyte	Synteni?			1998	micro-arrays of plant genes
Gene Trace		Genomics	\$17m	1998	licence genomics

The following tables document key subsidiaries in Europe and worldwide.

Table 3 European subsidiaries⁴

Name of the company	Director	Structure/ price of Ownership	Date of creation/ acquisition	Sites in Europe (countries)	Type of activity	Type of product or technology	Number of employees
Hybri Tech*			1985	UK,FR,DE,B E, +	R-P-C	hybrid wheat	
PBIC**		\$0.5bn	1998	UK,FR,DE	R-P?	wheat etc.	280
TwinAgro	jv with Bayer		?			Pesticides	

⁴ Type of activity : R = research / P = production / C = commercialisation

* HybriTech Seeds International was created in 1982. HybriTech Europe SNC was created by Monsanto and Pau Euralis in 1985.

** PBIC never published documents in its own name; all accounts were part of Unilever.

Table 4 Non-European Subsidiaries⁵

Name of the company	Director	Price \$bn	Date* of creation/ acquisition	Sites	Type of activity	Type of product or technology
Calgene/Gargiulo		0.24	1995+97	USA	R-P-C	tomato etc.
Agracetus		0.15	1996	USA	R-P?	genomics
DeKalb Genetics		4.4	1996+98	USA	R-P-C	many crops
Asgrow Agronomics		0.24	1997	USA	R-P-C	squash, soybean
Holden's		1.0	1997	USA	R-P-C	maize, etc.
Sementes Agrocere			1997	Brasil	R-P-C	maize, etc.
Cargill Intl		1.4	1997	US-Mexico	R-P-C	many crops
Mahyco			1997?	India	C?	cotton
First Line Seeds			1998	Canada	R-P-C	soybean, etc.
Delta & Pine Land ^{xxx}		2.0	1998	USA	R-P-C	cotton, etc.
D&M Intl	[D&PL]		1998	Argentina	P-C	cotton
Cargill-North America ^{**}		not sale		USA-Canada	C	

2. Monsanto's profile in agriculture

2.1 Current commercial profile

Round-up and Round-up Ready.

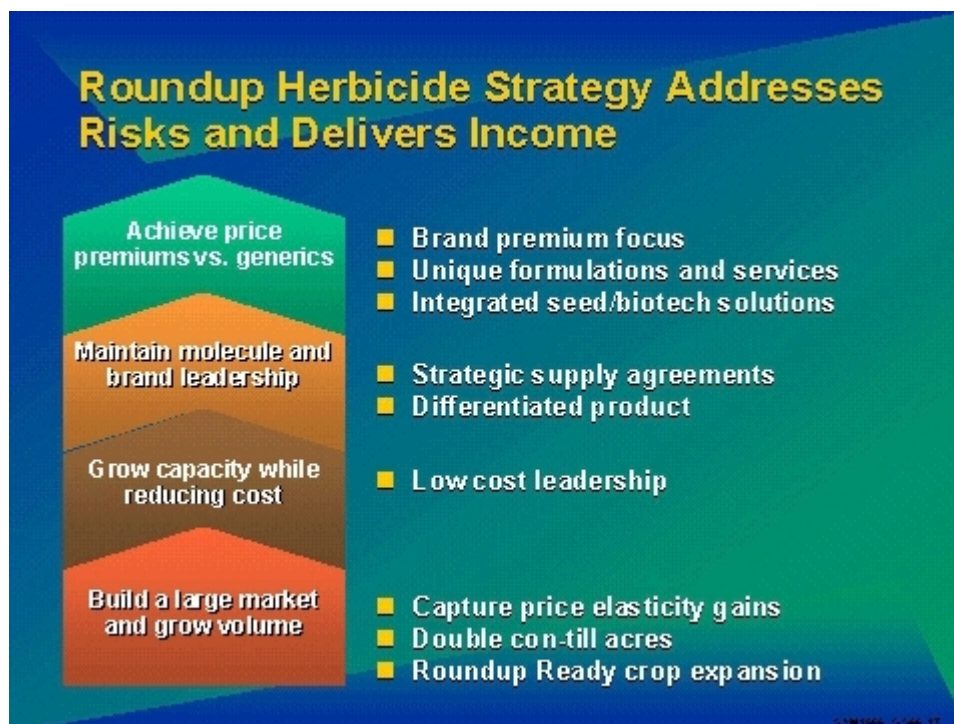
Monsanto's main agriculture product is Roundup, an enormously successful broad spectrum herbicide which has marketed as having relatively benign environmental impacts (AR, 97 and 98). A primary concern for the company has been that Roundup has either come off or is coming off patent in main markets. The company has responded with a strategy to prolong the lifespan of the product as the following slide from the Verfaillie presentation shows.

⁵* Two dates indicate a step-wise acquisition of the company.

^{**} Agreement to store, process and sell specialty products (being developed as 'identity-preserved', unlike the bulk commodity crops).

^{xxx} This acquisition has now been called off by Monsanto

Figure 2 Roundup Herbicide Strategy Addresses Risks and Delivers Income



The following quote from the Annual report expands upon pricing strategy and strategic supply agreements.

“A key factor in volume growth for Roundup is a strategy based on price elasticity, with selective price reductions followed by larger percentage volume increases. To support the strategy, we'll continue to expand our capacity for producing glyphosate...to meet volume growth and reduce costs...To create additional value, we've completed a series of agreements to license certain registration data for Roundup and to supply glyphosate from our low-cost production capacity” (AR 1998:7).

Roundup sales reportedly increased by 25% in 1997. According to SRI Consulting, glyphosate was being sprayed on 30m acres in the USA in 1997; that figure was expected to rise rapidly, even to double within a few years, thus outstripping its competitors (Wood/Fairley in CW 04.02.98).

Roundup sales increased by 20% in 1998, though the gains were offset by the lowered price which Monsanto had set in order to head off generic competition. Price reduction was an important factor in volume growth via price elasticity, especially in Canada, Argentina and Brazil. Monsanto can reduce the production cost of glyphosate through volume increases and technological innovation (AR 1998: 32-33). Whilst Round-up sales have increased, sales of other herbicides including Harness and Lasso have decreased (SEC, Jun30, 1999)

Seeds and traits

The prolongation of Roundup by integrating seeds, biotech and ag-chemicals has been a cornerstone of Monsanto's strategy. Commercially, the approach has yielded startling rewards as indicated by the growth of Roundup Ready seeds sales. RR-soybeans accounted for 35% of the US soybean market in 1998. Between 1998 and 2002 a three-fold increase in sales of RR crops is expected. A four-fold increase of Monsanto's insect-protected crops is also expected. (AR 1998: 13).

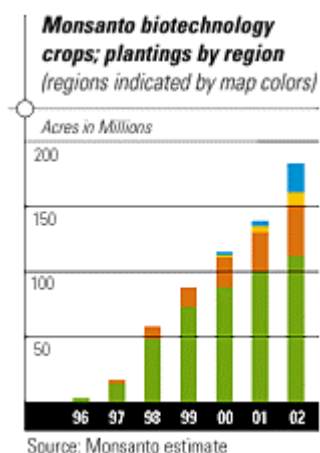
The commercial success of Monsanto's biotechnology-based products has been startling. Its Roundup Ready and Bt Cotton have sold well. In 1999, just four years from commercial introduction, an estimated 40% of the total United States corn, soybean and cotton acreage were planted with herbicide- and insect-resistant genetically manipulated crops. One industry analyst puts it as follows:

To put this level of adoption in perspective, one may consider it against that of the most dominant agricultural technology of the past—hybrid corn. To make the comparison more pronounced one may consider the average adoption rate of hybrid corn for only Iowa, Illinois and Wisconsin, which exhibited some of the highest adoption rates among all relevant states. The comparison is revealing. In 1999, an estimated 51% of soybean acres were planted with Roundup Ready soybeans. It took seven years for the selected States to reach similar adoption levels in the case of hybrid corn. In some States it took twenty years or more. *Bacillus thuringiensis* corn (Bt-corn), Roundup Ready and Bt cotton also exhibit adoption rates significantly faster than hybrid corn (Kalaitzandonakes, 1999)

Monsanto's plans for biotech crops are integrally linked to global expansion. "Plantings of commercialised biotechnology crops grew from approximately 18 million acres in 1997 to 57 million in 1998. Global plantings are expected to increase to 183 million acres by 2002, with an increasing share outside North America" (AR, 1998:12).

Latin America and Asia Pacific feature as particularly important in future plans, as the following graph shows:

Figure 3 Monsanto biotechnology crops; plantings by region



Green= United States and Canada
Brown= Latin America
Blue= Asia-Pacific
Yellow= Europe and Africa

Monsanto predicts that its product pipeline value is \$9 billion. The following table shows how this is planned.

Table 5 Pipeline Value - \$9 billion.

Pipeline Value - \$9 Billion				
	<i>Discovery</i>	<i>Phase I Concept testing</i>	<i>Phase II Development</i>	<i>Phase III Registration</i>
Weed control		RR forestry RR sugar cane RR alfalfa	RR wheat RR rice	RR sugar beets
Pest control		Cyst nematode soy Bt forestry Bt rice	Late blight potato	Bt/RR soy CRW corn
Yield	Corn yield Soy yield Cotton yield	Wheat yield Forestry growth	SY4 (soy yield) Corn yield Cotton yield	
Stress	Drought tolerance Salt tolerance		Continuous improvement via breeding	
Quality	Food Quality Feed Efficiency	Ideal poultry feed corn Improved fiber cotton	Ideal feed corn Crusher soy Uniform solids potato	Low-phytate corn
Nutrition	Food Quality Feed Efficiency	Low Sat Oil Phytosterol		

2.2 Monsanto in Europe

Europe is important to Monsanto for three main reasons. The first is sales. Monsanto's reporting categories combine Europe and Africa. Together they represent just under 20% of sales, with Europe accounting for the overwhelming bulk of this figure.

The second reason is that, since the purchase of the UK based Plant Breeding Institute, the UK and the rest of Europe have become much more strategically important. Maps 1 and 8 show some of the thinking around this. The acquisition of PBI is a product of the very aggressive acquisition strategy that Monsanto has pursued. It signifies a strategic decision to focus on wheat and therefore to make Europe an essential part of Monsanto's business (interviews).

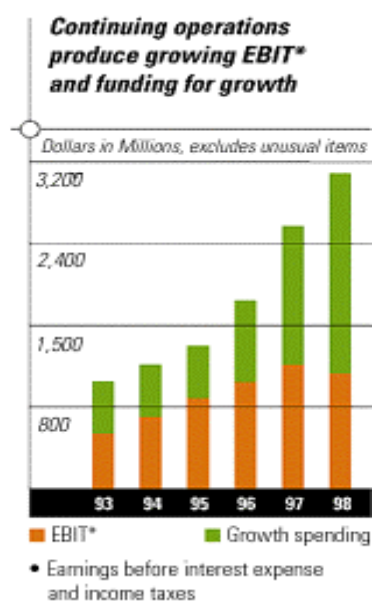
The decision to focus on wheat is tied to Monsanto's faith in new technology. The promise of wheat will not result from current market structure. The European and US markets that are the main markets are highly competitive and unlikely to increase substantially. It is likely that wheat markets in South East Asia will expand, but the real breakthrough will come from new innovations, such as a hybrid. As one manager put it, *"multiply the number of acres under wheat today by some technology fee, whatever way you do it, you obviously come up with a very big number"*.

The third reason is that what happens in terms of public opinion and regulation in Europe has an impact on what happens in the rest of the world. If European retailers decide against GMO crops suppliers from the world will opt to plant GMO free produce. An outcry about the safety of GM crops in Europe may reverberate in other continents (interviews).

2.3 Company earnings

Earnings from established agricultural, pharmaceutical and nutrition products grew until 1998, when continued investment in seeds and biotechnology caused the EBIT figure for that year to drop as the following table and notes explain.

Table 6 Continuing operations produce growing EBIT and funding for growth



“Earnings from Monsanto’s established products have provided funding for investments to expand our long-term earnings potential. By managing our leading products to deliver growing returns, Monsanto has increased EBIT (earnings before interest expense and income taxes, excluding unusual items), while also increasing our reinvestment of potential earnings in growth spending. The sum of EBIT and growth spending increased at a 24 percent compound annual growth rate from 1993 to 1998, from \$1.1 billion to \$3.1 billion.

The demand for investment in growth – for seed company acquisitions and commercialisation of products in our pipeline – is holding down EBIT today. But these investments are expected to support EBIT growth in coming years, at the same time that growth spending levels off (Annual Report, 1998).

A planned merger with AHP would have relieved the debt incurred from acquiring companies. When the merger fell through, Monsanto announced a divestment plan that involved in selling non-strategic assets. This plan amounted to about \$5 billion worth of sales and is in implementation. Assets being sold include: artificial sweeteners, garden products, pollution control, water treatment systems, biodegradable plastics and polymers. Administrative jobs cuts were also planned to reduce costs by \$500 million a year (C&I, 07.12.98). These plans are being implemented with divestments taking place on an ongoing basis.

The later section on innovation strategy discusses in more detail the company’s future plans for ag-chemicals, seeds and traits. The conclusion discusses some of the doubts that have been raised about Monsanto’s future projections.

3. Innovation strategy

“We have an almost unshakeable faith in our biotechnology” (Senior Monsanto manager)

In the opinion of managers interviewed Monsanto’s strategy is technology driven, pushed forward by a conviction in the vision of being a knowledge based company developing leading edge technology. The main research base is in St. Louis, although acquisitions such as Cargill and PBIC also have significant research facilities. In November 1998, the company also opened a new molecular plant breeding facility in Ankeny, Iowa. Monsanto has smaller research facilities in many locations.

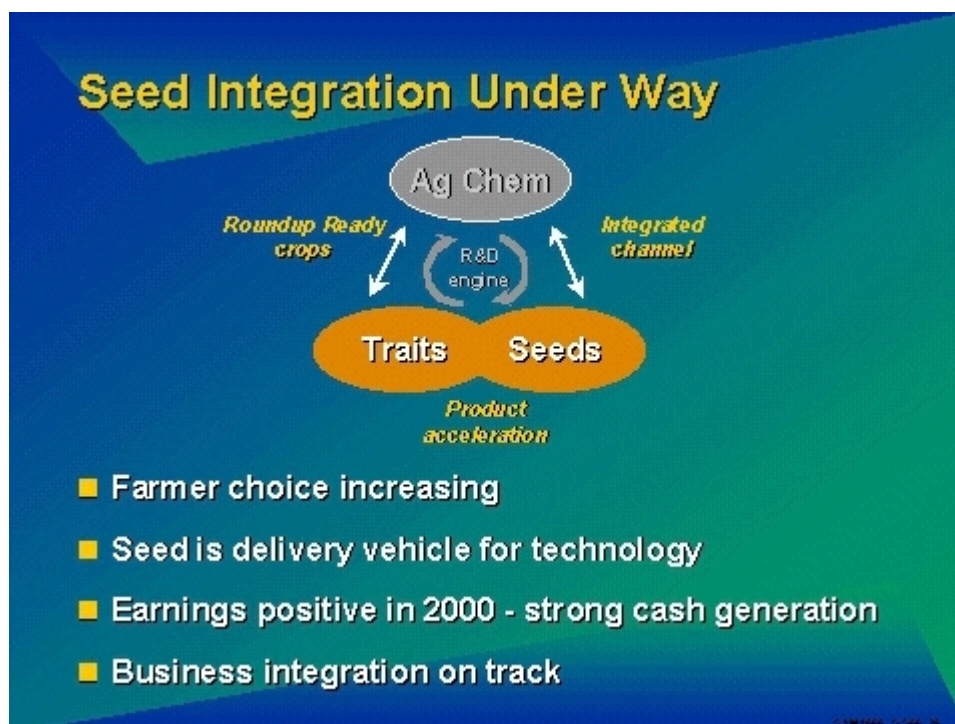
One manager commented that while the emphasis is now on biotechnology, Monsanto recognises that biotech doesn’t solve all problems. For that reason, Monsanto is still developing new herbicides such as Maverick for wheat. Other new agro-chemicals include MON 65500 a fungicide for control of take-all disease in wheat. Another manager commented that while the company is still producing new chemicals *“Its not having the same importance, its not the major focus of the company now”*.

A manager explained that the company had made an early commitment to biotechnology, aiming to be the first in breaking new ground. Before the first product was ready to market, Monsanto had *“made an upfront investment in facilities and the best scientists” and had made “a commitment to a 20 year development of GM crops”*. This has highlighted the role of new technology in the company.

3.1 Integration of chemicals, seeds and traits

The following slide taken from the Verfaillie presentation shows that the company planned to integrate ag-chemicals, seeds and traits.

Figure 4 SEED INTEGRATION UNDER WAY



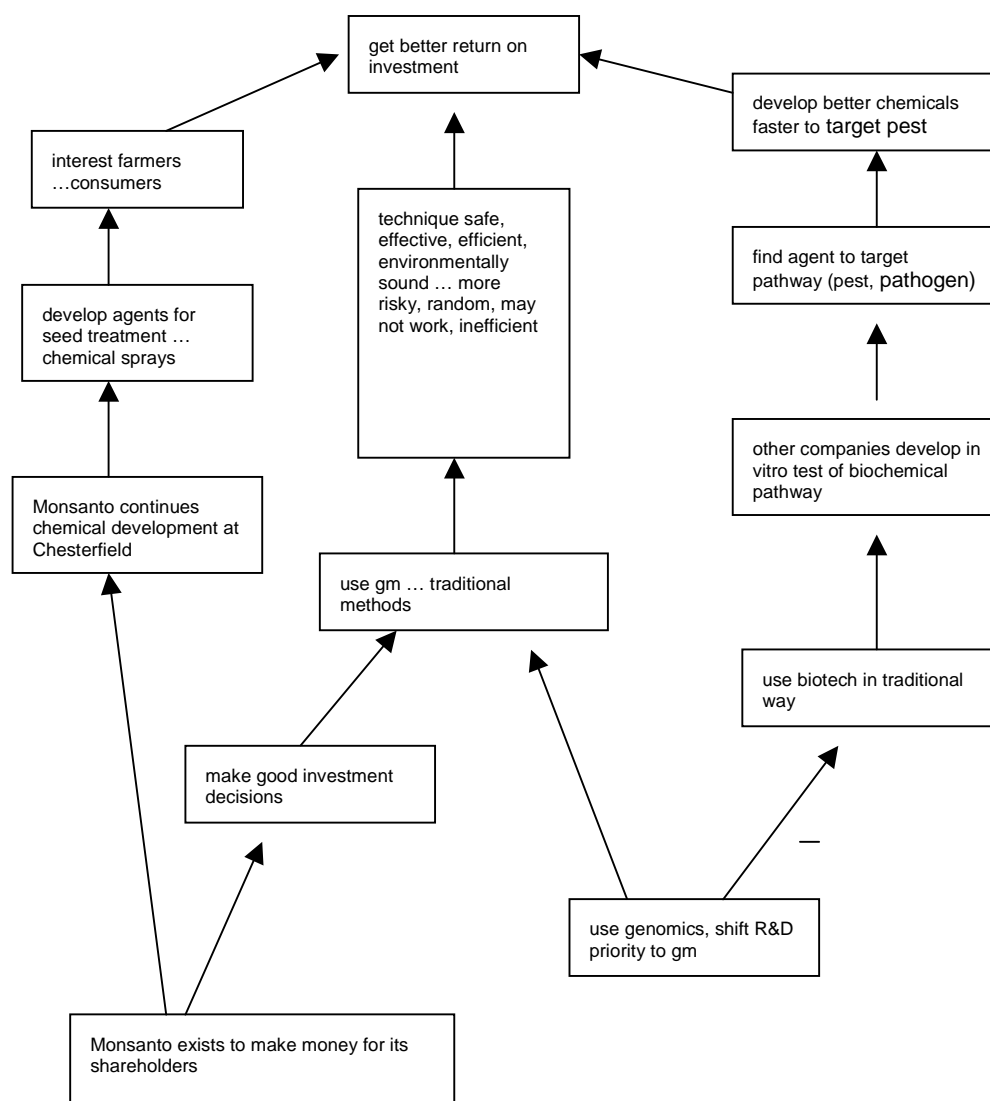
The company's strengths include genomics, germplasm (mainly from acquisitions), plant breeding, Roundup and resistance gene in RR-crops, patents on numerous transgenes for plants, seed distribution (mainly from Cargill acquisition and agreement).

Monsanto managers see the company as "built on the original marriage between chemistry and biology". RR crops were the obvious choice for development. Based on input traits which might appeal to the farmer, but not necessarily the consumer, the RR crops reflected Monsanto's view of its traditional customer base and prioritisation of them as primary stakeholders. One manager also explained that, at this point, R&D decisions were also very much science driven. Input traits, such as herbicide resistance in soya bean were the feasible option.

We ended up doing soya beans because we understood the trait, we ended up doing corn because it was possible...the fact is we did what we could do, we didn't follow it on the basis of, you know, if you looked at wheat, which is one of the harder crops to transfer... (Senior Monsanto manager).

Cognitive map no. 1 shows one manager's thinking with regard to the evolution of R&D decision making and where the company would like it to go in the future.

Map 1



Current products combine biotechnology and chemistry either in the shape of RR or inserting single BT genes into plants. Future products will be based on genomics. The aim here is to use genomics to develop better products which will work faster and more effectively. Another manager stressed the importance of seed treatments rather than conventional chemical applications such as herbicides, saying *"to develop the best chemicals, faster, that's not the route that Monsanto's chosen"*.

The other characteristic strand of 'second generation' products are products which exhibit output rather than input traits. These could include soyabean, rapeseed oils and plant derivatives that are good for the heart and blood vessels (FT, Nov 11, 1999). However, these products are likely to take some time to bring to market. As one manager put it, there is no "magic product" which will resolve short term perception problems. There are very few indications from either interviews managers or other sources that products designed to appeal directly to consumers are likely to be available soon. Map 1 indicates that the focus on farmers as major customers and stakeholders rather than final consumers. This route was chosen as the most likely to yield a better return on investments for shareholders.

The annual report states “The agricultural pipeline includes 14 new biotechnology products in the 1999-2000 period. The list includes eight agronomic traits in seven major crops, led by Roundup Ready sugar beets in 1999. These “input” traits improve plant characteristics that affect growth or yield. The pipeline also includes six quality traits – “output” traits that enhance the food and fiber produced by the plant. Plans for 2003 and beyond from the Monsanto/Cargill ‘Renessen’ partnership include:

- Corn enhanced with essential amino acids (animal feed)
- Improved-energy corn (animal feed)
- Improved energy wheat (animal feed)
- Improved low-phytate corn (animal feed)
- Improved milling wheat
- Improved oil seeds (improved processing qualities)
- Improved protein corn (animal feed)
- Improved protein soybeans (animal feed)
- (AR, 1998:21)

The 1998 annual report does note that the nutrition division is also working on human food supplements designed to maintain healthy blood vessels and hearts and a high carotenoid canola to combat vitamin A deficiency (AR, 1998:21)

3.2 R&D Spending and investments

Figures on R&D spend are not easy to decipher. In 1998 the company spent \$1.26 billion on R&D which is 15% of net sales. This includes agriculture and pharmaceutical and nutrition. Detailed breakdown of R&D spend does not appear to be publicly available. The Stock Exchange Commission reports filed every quarter provide some detail under a category called technological expenses (also used in the annual report). Quotes from recent reports indicate a very high level of spending in acquisitions.

“Agricultural Products EBIT⁶ (excluding unusual items) decreased \$25 million, or 8 percent, the first quarter of 1999, compared with \$306 million in the first quarter of 1998 because increased sales were offset by increases in SGA⁷ and technological expenses rose primarily because of the inclusion in 1999 of the acquired seed companies and spending on crop biotechnology initiatives” (SEC quarterly report, March 1999).

“Agricultural Products segment EBIT (excluding unusual items) of \$818 million for the first six months of 1998, a 2 percent decrease. The impact of increased sales for the Agricultural Products segment in the first half of 1999 compared with the first half of 1998 was more than offset by increase in SG&A and technological expenses, and amortization costs. The inclusion in 1999 of the acquired seed companies and spending on crop biotechnology initiatives caused an increase in SG&A and technological expenses in the first six months of 1999” (SEC quarterly report, June 1999).

3.3 Marketing Innovation

Monsanto has created a new structure for developing and marketing its biotechnology based products. It has both formed multiple agreements and partnerships and acquired seed companies and then pursued a strategy of licensing its technology to farmers. In the words of one manager:

⁶Earnings before income tax.

⁷Selling, general and administrative expense

We've had to learn how to do business differently...we've traditionally been in businesses where we've developed a chemical, sold it through dealerships to farmers, who came and bought it and said, I want that product, and it says Monsanto on it. I don't think there is a single bag of seed out there that has Monsanto on it, it has something about our technology on it, but if you look at soya beans, I think we have interests in two different soya bean companies in the US, but we have licensed the technology to literally hundreds. I think the number is well over 300 this year, because there are many. Soya beans are grown in more than 20 states in the US, and there are many different varieties of soya beans that are grown, depending on the geographic location, and so we, if we were gonna be successful commercially, we have to make the trait available by licensing, so we do the insertion, and then the trait is back crossed into other lines, by the seed companies, and they do that work.

According to managers interviewed, acquisition has become increasingly important to Monsanto's innovation and marketing strategy. The logic here is that simply selling the technology is not enough; the seeds also have to be excellent and appealing to farmers. Integration between all parts of the business is necessary and agricultural biotechnology needs to be marketed as a package.

The strategy is linked to finding large blockbuster products (Verfaillie presentation and interviews).

Monsanto is very very good...in all its businesses at building block-busters. [We're] not very good at actually having portfolios and developing portfolios, we're very good at building block-busters in all our businesses.

Senior Monsanto Manager

Monsanto has opposed segregating GM crops from non GM crops⁸. The idea is to sell products very widely in bulk.

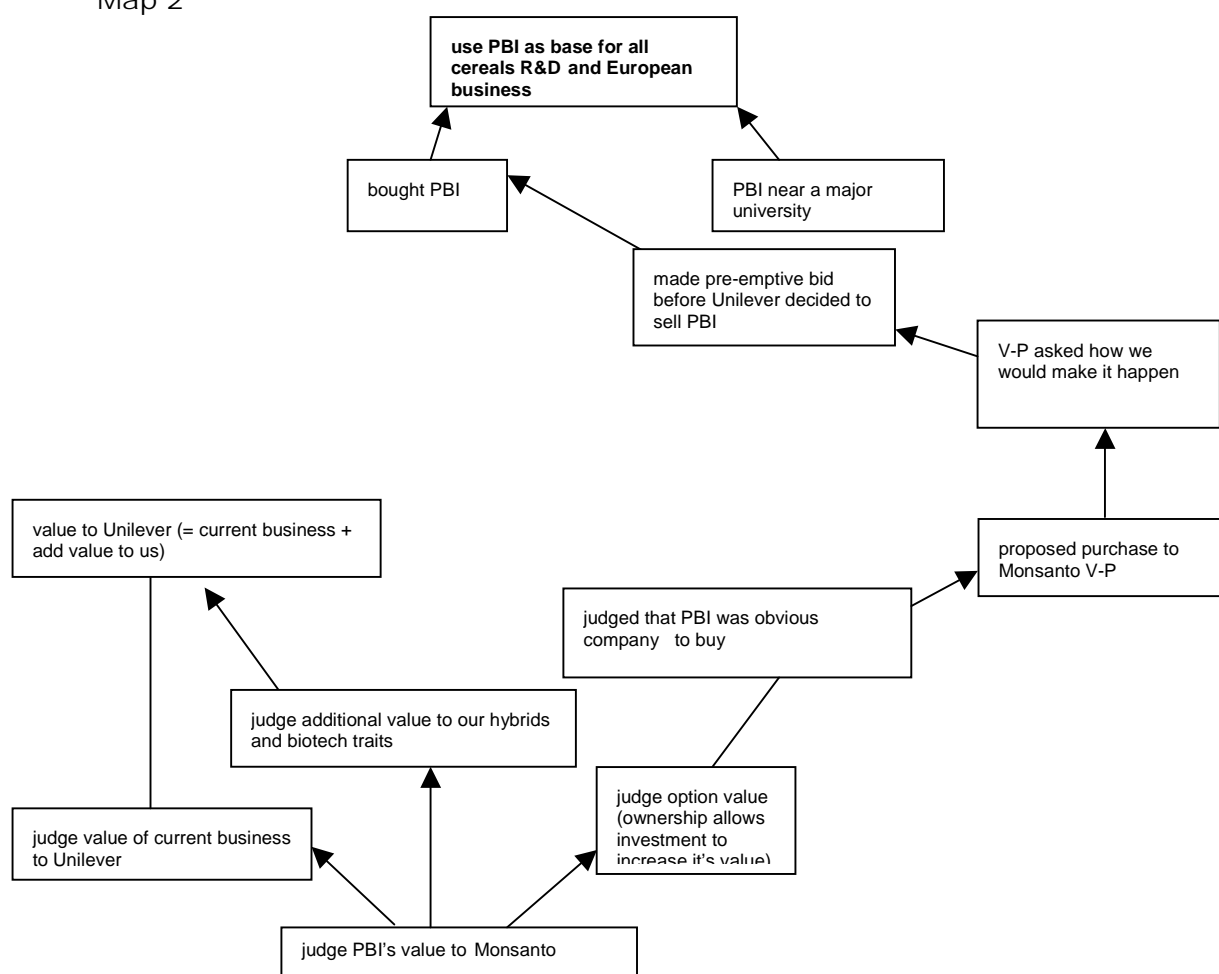
3.4 Acquisitions

The company spent a huge amount on acquisitions. In 1998 alone, "Monsanto acquired DEKALB Genetics Corp., Cargills international seed business, and Plant Breeding International Cambridge Ltd (PBIC), and entered into an agreement to merge with Delta and Pine Land Co. Monsanto's total investment in 1998 was more than \$4 billion" (AR, 1998:11). Since 1996, Monsanto spent over \$8 billion in acquisitions. (Fortune, 29.03.99)

Monsanto has pursued an ambitious acquisitions strategy in some cases paying top prices. Cognitive map 2 provides a senior manager's explanation of the way in which Monsanto judges a company's value to its business.

⁸ Company managers point out that it does not have control over farmers to whom seeds are sold.

Map 2



The distinctive characteristic of this method is that the value of potential acquisitions is measured in part by the contribution it could make to Monsanto. There is no pretence at an 'objective' value. Another manager explains it following terms:

When we valued PBI we actually valued it...from a number of criteria – on its current business, what the current business was worth, over a period of time, using net present value classic methodologies to value businesses – so we decided how much it was worth on that basis, that was current business. We looked at what additional value having access to PBI and all its assets would bring to our highbred business – so there's value there. We looked at...how its influence on our highbred business would bring value to our biotechnology traits...and then we also looked at PBI in terms of what it gave us, from the point of view of what we call option value – option value is a term or concept which comes mainly from the oil industry...its used where, if you own a particular asset, you then have an option to invest further in that asset to gain extra value. So there was an option value associated with PBI as well...(Monsanto senior manager).

Monsanto has not always decided to buy early however. Whilst the Delta and Pineland acquisition is now off, it is illustrative of Monsanto's approach. In the case of Delta & Pine Land, a period of successful collaboration was followed by attempted acquisition. The purchase was deemed necessary because although Bt cotton has sold extremely well, the Monsanto Bt gene was not originally inserted in the best variety.

We obviously feel that we have to own the seed company. One of the things we used to be very bad at, I think, is that we used to think that our gene was what gave seed value – because our gene enabled the...value of a seed to be increased – the Bt gene for example. But in fact, of course, the seed industry, the seed business, which we are now in, is responsible for marketing tens of thousands of genes and traits, in every seed, so I think we...have probably realised that...all the gene traits, including the ones we're inserting create value....If you talk to Delta Pine farmers, after they've planted for one year, and seen huge yields benefits and made a lot of money of it, would still argue – because the original variety was not the best variety that was on the market, the reason for that was because of lead times – you know seed varieties only have a limited life span, generally, and then a new one comes along 2 or 3 years later and it's incrementally better – so the one that this one went into was sort of last year's model. That's an oversimplification but it was clear that if you talk to farmers the year after, even though they'd had a really successful year, they said, if another company, another seed company, cotton seed company, came out with another cotton seed non GM that they thought was better for all those other traits, disease resistance, yields, drought tolerance, whatever it was they were looking for, strength of fiber, all that sort of stuff – they would swap back from GM rather than just sticking with GM – so its that understanding of the value of every single gene trait, that I think is the significance here. That's one thing that's changed. On the other hand, and this is a personal opinion, an immense amount of the phenomenal relationship that we have with Delta Pine, when we did our joint venture, was down to the personality and integrity of the individuals involved in the deal. And the person who did the deal is now head of seeds for Monsanto, and the personal integrity of that individual, was such that every time the contract, or whatever, it was,...was reached for because there was an impasse or a problem, in our working together, this individual would be summonsed to deal with it, and in the end of course, that's unsustainable for a big corporation...(Senior Monsanto manager).

Monsanto could be thought to have lost heavily out of this deal; ironically Delta & Pine Land prospered enormously from the sale of Monsanto's Bt technology and the company's value rocketed.

I don't see why we had to buy it, I really don't see why we had to buy it...when I think in 1993 or something we could have paid \$30 million for it and when we bought it we paid \$1.8 billion or something like that...we ended up...paying back every penny we made (Senior Monsanto manager).

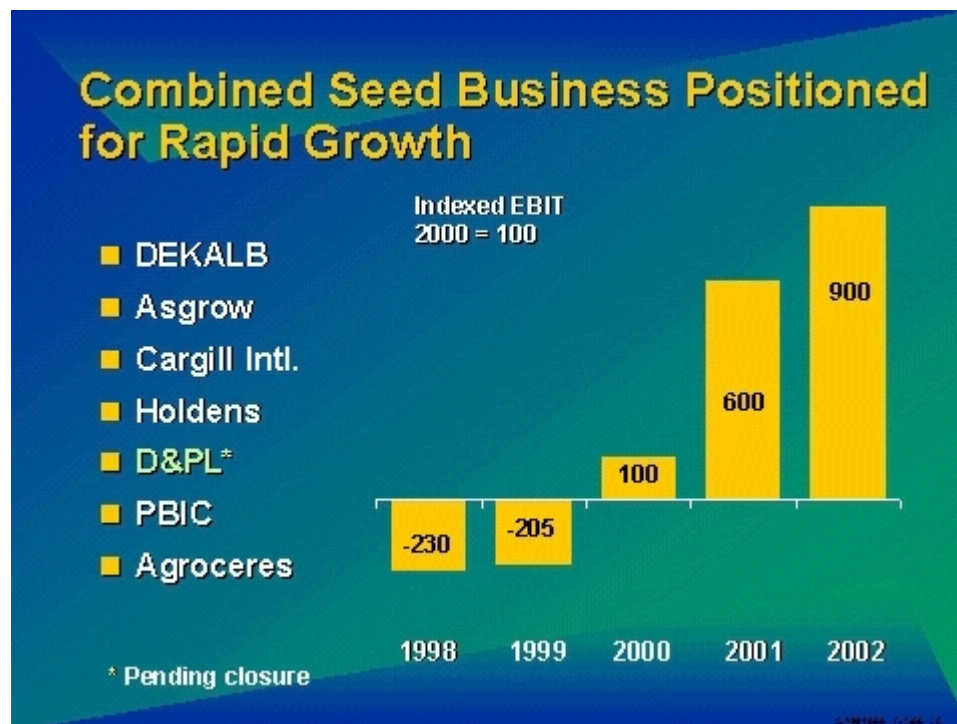
Monsanto has now withdrawn its offer for Delta and Pineland, blaming the failed acquisition on the US Justice Department.

Company documents put the case that the benefits of owning seed companies are clear. The 1998 annual report claims that Asgrow (acquired in 1997) has played a key role in the rapid expansion of RR soybeans, with its elite germplasm, brand equity and channel access (AR 1998: 13). Additionally,

"Monsanto will be able to widen the availability of traits and establish a competitive world-wide position in major crops...With the addition of these seed businesses, Monsanto will be able to deliver solutions to growers in an industry that is being transformed from a price-drive commodity market into one in which quality and innovation yield higher values and greater returns" (AR, 1998:11).

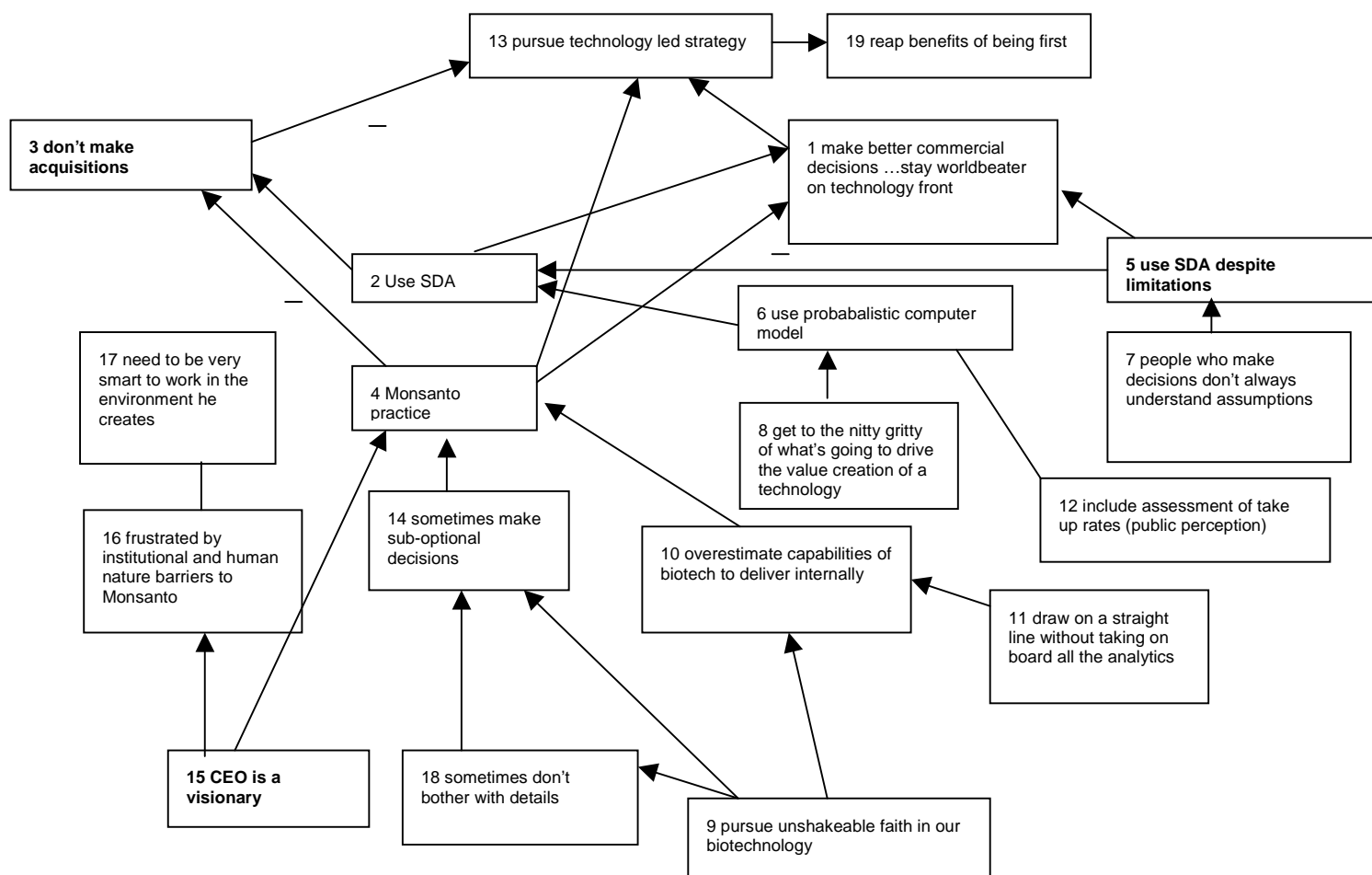
The following figure shows projected income from the acquired seeds businesses.

Figure 5 Combined seed business positioned for rapid growth.



One important aspect of Monsanto's acquisition strategy, according to one manager, is that it reflects the company's belief in technology. This technology-led ethos runs deep in the company. Map 3 shows one manager's thinking about this issue.

Map 3



It is an overall goal of the company to pursue a technology led strategy. Whilst Monsanto employs a sophisticated decision making tool called Strategic Decision Analysis (SDA), the outcomes of this process are often overridden. Monsanto practice is to stay a world leader on the technology front rather than make better commercial decisions. The discrepancy between the analysis-based and vision-based decision approaches is particularly apparent over the issue of acquisitions. In notable cases, SDA would indicate that acquisition might not be the best strategy. Still, Monsanto has decided to go ahead with acquisitions. This reflects the overall vision which drives the company and which is fostered by the CEO. It means that details are not always fully taken into account and that sometimes “sub-optimal decisions” are made. The map portrays well the tensions between maintaining technology at the centre of strategy and making short term financial decisions.

3.5 Patent licenses and disputes

Patenting and licensing are extremely important components of Monsanto's innovation strategy. As a leader in the development and introduction of new technology, the company uses patents and licenses both to bring in new science and technology and to expand its market reach. A drawback to the strategy is that there is a considerable amount of legal activity that the company must deal with. Appendix 2 contains a summary of some of Monsanto's agreements, patent claims and disputes.

4. R&D Decision making: organisation and culture

Monsanto is an American company. As one manager put it, in Europe “[as an American corporation] we’re perceived to be powerful and we’re over here”. Whilst local operators have a large degree of freedom in how to implement strategy, strategy itself has clearly been driven from the centre. The company also cultivated strong links with US politicians and US. In line with strong US leadership, an important component of Monsanto strategy has been its efforts to establish a very strong presence in key US agriculture markets. However, outside the US and with other chemical and food companies, Monsanto’s style has provoked intense hostility. Moves are now being made to change. Discussions with NGOs and the decision to halt work on the ‘Terminator’ gene are indicators of a new approach. Organisational decentralisation discussed later may also be significant.

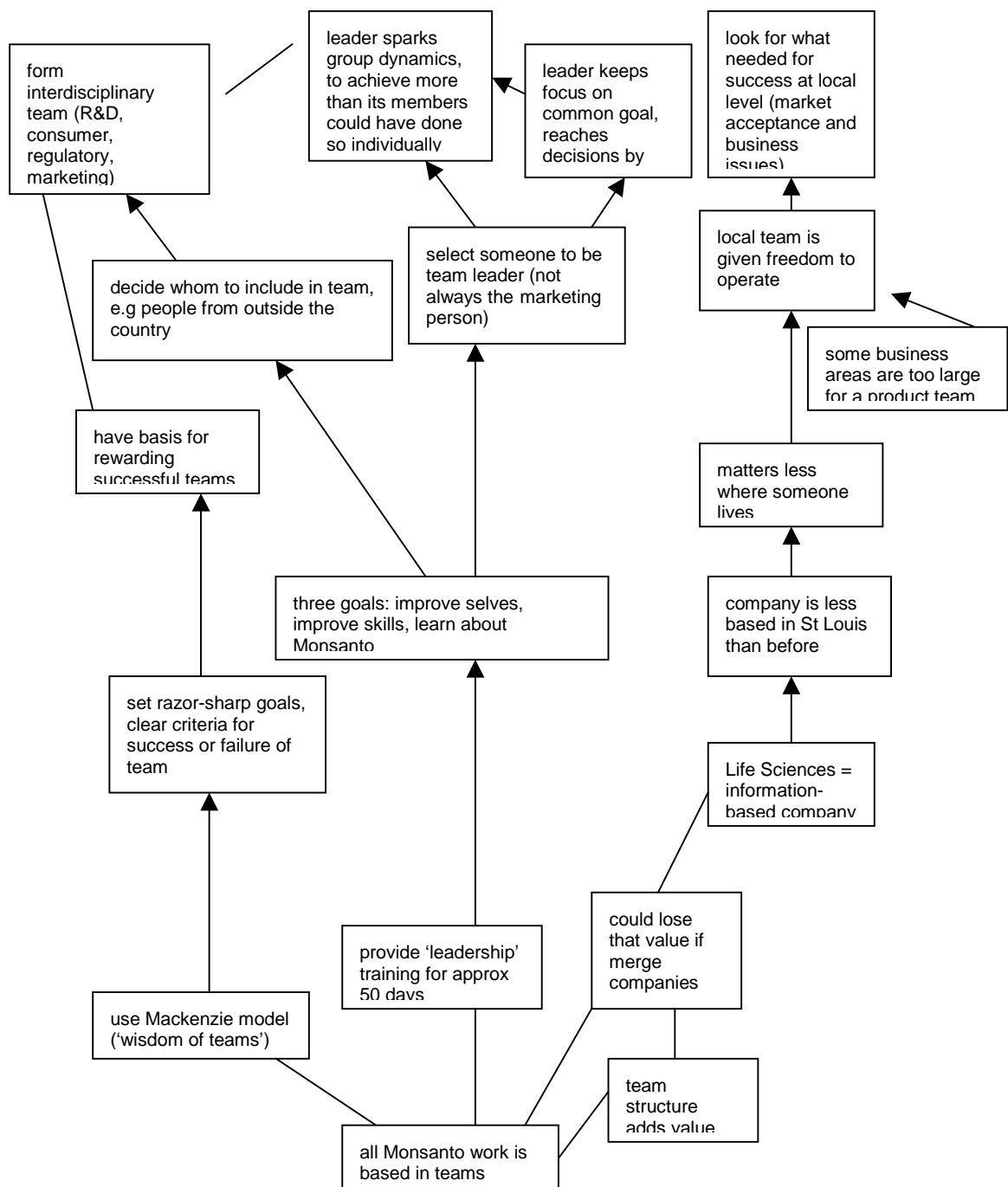
Monsanto is organised in multidisciplinary teams. Teams are based around crops, regions and products and include members from different functions. So, for example, the wheat team will have marketing, regulatory, ag-chem and biotech membership. Teams put forward plans to the senior management team.

“The strategic business teams are there to actually look at the crop for which they are responsible, and actually think of how Monsanto’s technologies fit within that crop. There are technologies which go across all crops, there are technologies which are crop specific, and it’s the job of the business teams to think about the crop, think about the technologies, think about the geographies and come up with projects and products that make sense” (Senior Monsanto manager).

The same manager said that most of the teams are based in St. Louis, although they include members from all regions. The exception is the wheat team which has a base in the UK as well as the US. Efforts are being made to devolve team structures.

The team structure is an important part of Monsanto culture as shown in Map 4.

Map 4



According to this manager the belief is that teams deliver more value; they contribute more than the sum total of individuals could deliver. The map also shows that teams are thought to be very important in the context of a diverse global life sciences company where information is key.

However, the team spirit runs in parallel with the dominant ethos of technological excellence and vision driven decision making which dominates decision making in the company. It is this vision-driven aspect of Monsanto's style which is key to understanding the company. This is

perhaps not so much to do with the structure of the company, but more to do with organisational culture.

“Monsanto is like a shoal of fish and the shoal of fish...changes shape, and it changes direction, and moves seemingly without a direct lead in that shoal of fish, but it moves for the benefit for the whole of the shoal. If you look at any individual fish within the shoal any individual fish...within his sphere moving in different directions to the shoal as a whole, being carried along by the shoal but moving in different directions, testing where the limits are – Monsanto’s very much like that actually – it’s like a shoal of fish, it moves along as a whole – in the correct direction, but within your shoal you could have have a lot of alternative movement in different directions....I’ve never found people in Monsanto say ‘you can’t do that’” (Senior Monsanto manager).

The strategic direction is said by managers to be strong with a high level of informality. The following senior manager is talking about the way in which a proposal to make the large PBI acquisition came about.

I was in St.Louis in February 98, by pure chance I spoke with for 10, 15 minutes with Henrik Varfaillie...and we were talking about how things were going in Europe and all the rest of it and I said “yeah we really need to buy PBI to actually give the strength to the wheat group we’d been talking about”....He said “right, how are you gonna make that happen”. Well, you know, go and make that happen and we took that as a sort of green light to start building our pre-emptive bid...(Senior Monsanto manager).

Another senior manager talks about the impact of the current CEO, Bob Shapiro, on the business:

..he is a visionary...he’s a wonderful concepts man, he’s an inspiring concepts man...he just gets frustrated by the sort of institutional barriers and human nature barriers that prevent this corporation...from blowing the socks of the universe. And if there was any criticism of him it would be that, actually you have to really sharp to operate in that environment and not get a bit lost – he is so passionate and he encourages people to follow their passions so much that sometimes work doesn’t get done – sometimes detail gets missed out – never on the technology, never on the technology, but when it actually comes to dotting Is and crossing Ts on all the stuff that surrounds it, all the stuff that I suspect he’d like to wish away...we have allowed ourselves, under his leadership, to not bother with the details. The big picture stuff is fascinating – you know the ‘save the world’ and here’s the technology that’s gonna do it, but the intricacies of how particular products go to achieve various things in a particular market...(Senior Monsanto manager)

Organisational changes are being implemented. The problem is seen as one of not dealing well with non-US cultures and of needing to decentralise.

According to one senior manager, Monsanto is at a crossroads. The company is confronting difficult decisions and change at a number of levels. One response to the perceived crisis is to commit to further decentralisation. “*The biggest problem we have is ‘getting it’, understanding nuances of different cultures*” the manager says and the response is to increasingly allow strategy to be made locally. Thus, while operational decisions have always been delegated, now local teams will be allowed to take decisions that may impact on the US and overall strategy. The other side of this coin is, however, to increase the extent to which local managers buy into the central vision; “*Corporate ethics need to be understood and ingrained by every single person*”. This will give top management in the US the confidence to relinquish its hold on strategic decision making and enable a greater degree of trust in people’s reactions.

Decentralisation is then running in parallel with new emphasis on understanding the overall mission of the company and personal loyalty. New structures are also being implemented. One manager commented that previously, Monsanto management had been based on chaos management theory. It was like 'a pinball machine' which batted decisions around amongst the multidisciplinary teams. This is being replaced with a 'Strategy committee' which meets once a week and through which all R&D and product development decisions have to pass. Also, Europe and Africa have been placed under the leadership of one manager.

5. Concept of clean technology and product by the company

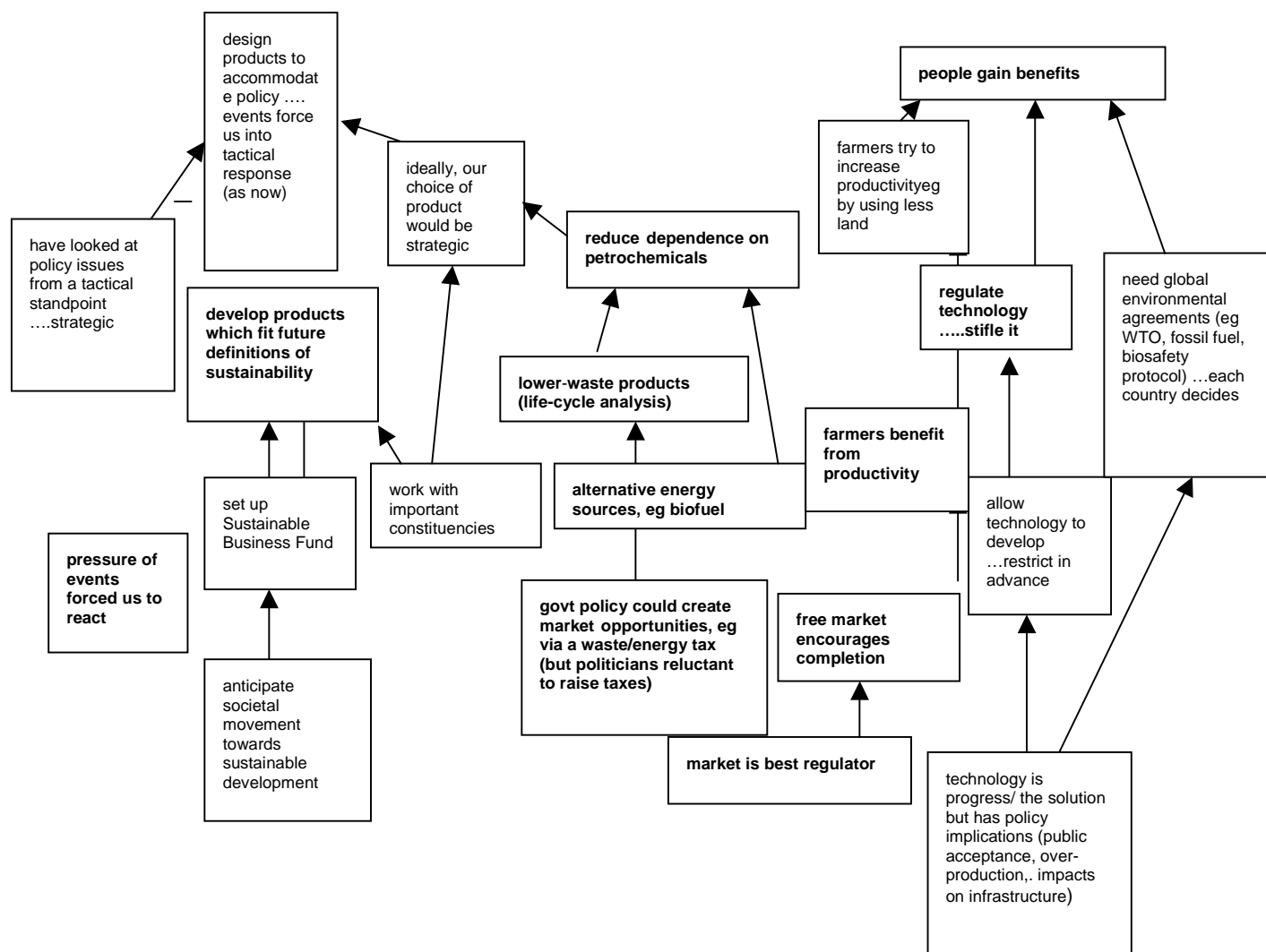
Monsanto's understanding of sustainability relies heavily on the power of biotechnology and genomics. The idea is that increasingly sophisticated use of genetic information can replace the use of materials and energy and reduce harmful effects on the environment. The challenge is to begin to de-couple economic growth from growth in the use of energy and raw materials (RSD, 1997:2) A life cycle assessment is used to evaluate the sustainability of production and products. In conceptual terms, Monsanto's view of sustainability is close to USDA's interpretation. It endorses agricultural practices which enhance environmental quality and the natural resource base whilst sustaining economic viability (RSD, 1997).

Monsanto's approach to sustainability is to demonstrate that with new technology and new information possibilities, there need not be a trade off between feeding a rapidly growing population or preserving natural habitats for bio-diversity. The task is to do both with more sustainable high-yield agriculture. The company views the risks of not pursuing high yield agriculture, including biotechnology, as high. Bob Shapiro is quoted as saying,

"Using information is one of the ways to increase productivity without abusing nature. A closed system like the earth's can't withstand a systematic increase of material things, but it can support exponential increases of information and knowledge. If economic development means using more stuff then those who argue that growth and environmental sustainability are incompatible are right. And if we grow by using more stuff, I'm afraid we'd better start looking for a new planet.... But sustainability and development might be compatible if you could create value and satisfy people's needs by increasing the information component of what's produced and diminishing the amount of stuff".

Map 5 shows one senior manager's thinking around sustainability.

Map 5



Sustainability is central to Monsanto's strategy and the establishment of related institutional forms, such as the Sustainable Business Fund* is designed to give it a high profile. It is acknowledged that ideally a more "strategic" rather "tactical" approach to policy might have been beneficial; as it is Monsanto often reacts to policy signals rather than a more pro-active approach. On the other hand, the manager thinks that technology has its own logic and development of new technology can perhaps only ever be regulated in retrospect, rather than specifically designed to fit future policy priorities. Global regulatory solutions are needed in today's international business environment.

The manager also notes that current products, such as herbicide resistance, whilst they may offer environmental benefits are difficult to portray as 'sustainable products'. A number of products, which are more easily portrayed as 'sustainable' and have clear health benefits, are

*Also set up in 1997 were seven 'sustainability teams'. Teams are The Eco-efficiency team; the full cost Accounting team; the Index team; the New Business/New Products team; the Global Hunger team; the Communications and Education team. These teams were not mentioned in interviews.

in the pipeline. However, these will not be at a commercial stage of development in the next couple of years (Interviews).

Monsanto holds that herbicide resistant and Bt cotton have both been shown to result in lower use of chemical inputs. Conservation tillage is significant in the United States, Latin America and Southern Europe. The unprecedented steps taken to intervene in farmers' management of Bt cotton in order to minimise resistance in insects is put forward by the company as evidence of its high degree of awareness about sustainability issues (HBS, 1997). New EPA regulations here made it mandatory for farmers to limit the amount of B7 Cotton used in an effort to limit resistance build-up. Monsanto has endorsed these regulations. An additional advantage of Monsanto's decision to market directly to farmers is the extensive database, which it has at its disposal to monitor environmental and product factors (interview).

In 1997, Monsanto commissioned an independent study on sustainability and the Roundup Ready soyabean system. Key findings of the study are as follows:

Sustainability and the Roundup Ready Soyabean System

- The Roundup Ready soyabean system provides better weed control and reduces crop injury compared to regular soyabean-herbicide systems.
- Because the System provides better weed control and reduces crop injury, it improves farm efficiency by optimizing yield, using arable land more efficiently, saving time for the farmer, reducing herbicide use in season, reducing foreign matter in grain and eliminating crop rotation restrictions.
- Because the System provides better weed control, it encourages the adoption of conservation tillage, especially no-till – a farming method that leaves the soil undisturbed except for planting and nutrient injection.
- No-till promotes sustainability in agricultural production systems – an economically viable method of agriculture emphasizing environmental stewardship of the land – which is good for the farmer and good for the environment.

Herbicide Use for In-Season Weed Control in the Roundup Ready Soyabean System

- In 1996 and 1997, herbicide use was, on the average, lower in Roundup Ready soyabean fields than in other U.S. soyabean fields, partly because growers were able to achieve superior weed control without preventive herbicide treatment (e.g. soil-incorporated herbicides), which are traditionally used before planting of the crop as “insurance” against weeds that might appear later (Monsanto, Backgrounder, April, 1998).

The following table, taken from the dossier, outlines some of Monsanto's claims for the environmental benefits of the technology.

The figures below compare Monsanto's crops with pesticide-treated crops, mainly from results in North America. Monsanto sources are cited with abbreviations.

Bollgard (Bt) cotton: reductions in insecticide sprays

1996: 90% reduction on 1.8m acres; 7% yield increase (info from *RSD*)

1997: 85% reduction on 2.5m acres: 14% yield increase in Southeastern USA (*Achievements 1997*)

NewLeaf potato: reductions in insecticide sprays

1996: 40% reduction on 10k acres (*RSD*)

1997: 40% reduction on 30k acres; 5% yield increase (B&W, 1998: 136)

YieldGard maize

1996: 8% yield increase (*RSD*)

field tests: 10-15% yield increase (B&W, 1998: 140)

[Little maize was formerly sprayed with insecticide, for lack of an effective one, so Bt maize has little scope for reducing insecticide use.]

RR soybean: reductions in herbicide sprays

1997: 22% average reduction, ranging between 11-30% (B&W, 1998: 140)

Some independent studies are far more variable. These are discussed in the concluding section.

6. Macro-economic factors and public policies

Overall, policies seem to be dealt with on tactical rather than strategic level.

...Are we looking at the policy issues more from a tactical standpoint? I must say, we probably have, no-one would want to say that, we would much rather say we have included them into our strategic thinking (Senior Monsanto manager).

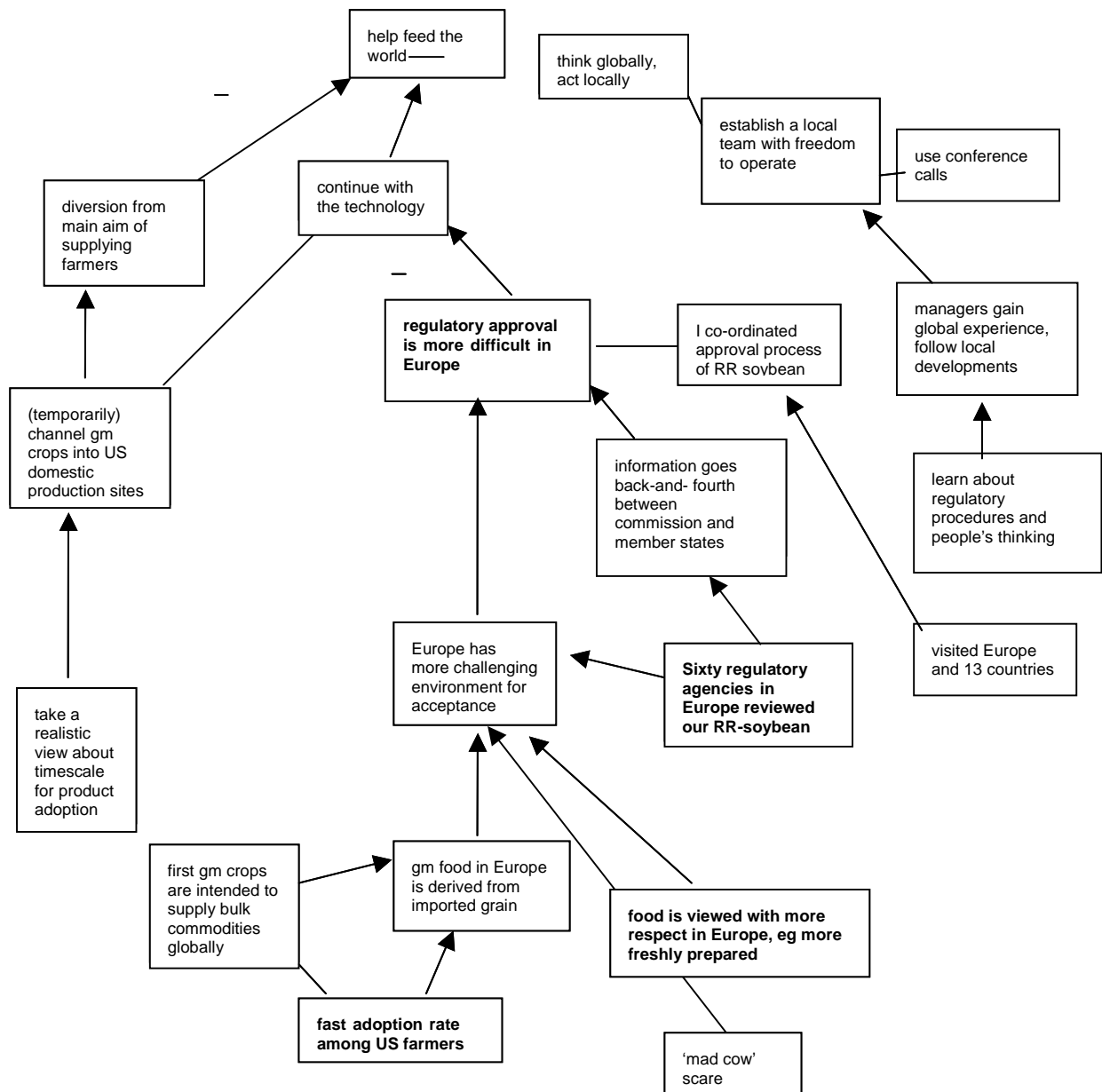
Policies which were not mentioned in interviews include science, technology and innovation policies.

6.1 Risk regulation and public perception

...the fact that only 9 products have been through the...EU system, versus 30 in the US – the fact that the 9220 deliberate release process is under constant scrutiny and is being looked at now and from a revision standpoint...those are the policies that really affect us. (Senior Monsanto Manager)

Map 6 shows one Monsanto manager's thinking around regulation.

Map 6



Whilst there are no plans to withdraw from European crop production, the map does spell out perceived difficulties in continuing with the technology in the European context. The European system is perceived of as non-functioning. The large number of regulatory authorities involved in approval is viewed as unwieldy. Over 60 regulatory agencies were involved in the review of RR-soybean. Monsanto is keen on decentralising and learning more about local regulatory contexts, but so far this has had little impact. If biotechnology was uncontroversial the current system might function. As it is, however, national decisions are subject to political pressures and this prohibits any decisions being made. The clear preference from a regulatory manager interviewed is for a central agency (as for

new medicines/pharmaceuticals) to be established. Approval by this body would apply for all EU countries (Senior Monsanto manager)

Recent experience has made the company *“cynical and pragmatic”* about European regulatory systems. In one manager's opinions the regulatory structures which have been set up are ill suited for current purposes. Regulatory agencies were designed to brief politicians about whether new technologies were safe rather than “tell a risk vacuous public whether products are safe”. Risk regulatory agencies are not designed to communicate to broad sections of the public, they are technical bodies.

One manager predicted greater regulatory hurdles for chemical products in future. This may ease the passage of GM products.

Policies dealing with herbicides or pesticides are certainly having an impact. We think its actually positive for us. Some of the critics argue that GM crops wil cause higher use of pesticides, we wouldn't think that's the case....We also think that it's a more sustainable way of producing food, that particularly with the insect tolerant crops you much less product. With herbicide tolerant crops you still use herbicides, but hopefully you use one that has a nice environmental profile, and you get superior weed control, which gets maximum value of the crops. That's our story (Senior Monsanto manager).

...pesticide reform, yes, that affects us...our ag vision is abundant food and a healthy environment – and we recognise that the constraints on the traditional business that we were in, which was agrochemicals, were only going to get greater, the actual hurdles were only going to get higher and more costly to overcome...that affects what we did and why we did it and will continue to do so (Senior Monsanto manager).

Specific concerns about the way in which glyphosate might be affected by European regulations were not mentioned, although it might be that if interviews were carried out now this might be a greater concern.

There is also a feeling that current favour shown towards organic agriculture might be short-lived.

I'm waiting for the first time that we have an outbreak of E. coli in the United Kingdom which is traced back to using animal manure on organic food, and the first time that hits – and then the question will be asked of Safeway or Sainsbury's, you know, how are ensuring that there was no cross contamination...I'm waiting for that one, how that's gonna be handled....

Managers are aware that Monsanto has not succeeded in winning over public opinion in Europe. Links between risk regulation and public perception are not articulated except in manager's perception that a breakdown in trust is at the root of calls for further regulation and rejection of the technology (interviews).

There is also now a perception that Monsanto is not able to deliver reassurance to the public. *“Its no good if it comes from us”*. Managers acknowledge that it is difficult for consumers to perceive the benefits of the technology as products are designed for farmers' benefits rather than end consumers (interviews).

No current plans exist to withdraw from Europe as a result of perceived difficulties with public opinion (interviews). The timelines for R&D are too long for the difficulties to have had an impact on decision making. In answer to a question about whether negative public perception and regulation would impact on R&D, one manager said the following:

The simple answer is no, but we have a more realistic view of the time-frames and we have a view that we just can't develop a product and introduce it – we have to work with the constituent groups, the food industry, the retailers, and that's difficult

because there are lots of views about this...but we are still committed to the technology (Senior Monsanto Manager).

Even the move towards product which give more direct consumer benefits is "*absolutely science led*". This is because you can't tell in advance what will sell.

A number of managers expressed the view that 'public' opinion is not so much the problem. The problem is that the press sees a good story and that retailers respond to that and interest groups play a key role in fuelling the problem.

There is a feeling in the company that more could have been do to promote the technology earlier and that governments could have played a bigger role.

I wish we had done more of it...I wish we had worked more with the food companies and more with the science media, to put educational information in front of people, in places where we did that we had some positive results, one country in Europe where acceptance of the technology seems to be...successful is the Netherlands, there are many products that are labelled, but the government sponsored an information programme, there were public information sources that people could turn to, the government stood very much behind the technology, for the standpoint that they had reviewed it, that they affirmed its safety....Maybe its partly cultural, I think partly it is, but the other mistake to make...it is an important one not to make, is to assume that there is some Europe approach or Europe attitude. There's far less similarity in Europe than there is in the US (Senior Monsanto Manager).

Towards the end of 1999, very senior company managers began to go beyond a desire to educate, and began to stress their interest in listening. A manager disowned an earlier very high profile UK advertising campaign saying "We do not see the environment as something that will change by a PR initiative" (Dow Jones Newswires, Oct 6, 1999). The company called a halt to its 'terminator technology' and attempted to engage in dialogue with NGOs such as Greenpeace and the Soil Association. Bob Shapiro addressed a Greenpeace conference saying: "We have been working on it (biotechnology) for 20 years, and that is the source of [our] convictions, but because of that, I think we have tended to see it is our task to convince people, in short that we are right and that by extension people who have different points of view are wrong or at best misguided.... We behave then as though this is or should be a debate and unintended result of that has privately been that we have irritated and antagonised more people than we have persuaded... because we thought it was our job to persuade too often we have forgotten to listen". The aim now is to engage in "Stakeholder dialogue" (F.T. 11/11/99).

6.2 Trade, environmental and market regulation

Environmental regulations are in the minds of interviewees likely to become increasingly rigorous. However, because of measures taken in the direction of sustainability, Monsanto is confident of its capacity to deal with environmental policy pressures.

The company took an early decision not to segregate GM and non GM crops and has encouraged moves from the WTO to force Europe to accept unlabelled GM products. For commodity crops, the company perceived that segregation was not economically viable, nor was it something that the company could control.

...retailers believe that they have to take the GM out of animal feed supply – now that's not a problem, there are lots of people in the world who will offer you GM free soya and corn, there are lots of people who are doing that, but they are charging a price for it. And the retailers won't pay a penny more...there is potential for lots of promises and smoke and mirrors and, you know, 'we're now GM free' – you know actually they're not, because you can't detect it...members of the food

chain are getting very, very tense and very aggressive about their capacity to produce GM free animal feed – you can't measure it, you can't get hold of it – and the only way you can get hold of it is to pay a premium and at the moment retailers are unprepared to do that....The biggest problem we've got at the moment is that our name is mud because we are perceived to have caused this problem...we don't trade the beans, we sell seed, people buy it....Market forces will prevail...the investment [for two channels] is huge and there's no need for it from a substantial equivalence point of view and the fact that it hasn't happened, the effect of that is that you know people can't make money from it, otherwise everybody would have done it – but people have run the numbers and decided its just too risky, and they're not gonna, you know we're talking commodities here, so the market just isn't there (Senior Monsanto manager).

Interviewees considered reform of CAP and Agenda 2000 measures as tactical or operational rather than strategic issue. The direction of reform is towards greater market liberalisation, but this will not happen quickly. *"CAP reform is going to be stepwise, its going to be incremental, not fundamental..."*

For the most part Monsanto managers have enormous faith in market liberalisation. Market pressures will force farmers to become more efficient and this will favour new products such as herbicide resistant varieties. It is the lack of competition, which poses more of a problem. Market liberalisation will force a demonstration effect and this will increase the rate of uptake of new products. Monsanto therefore considers itself to be prepared for the future combination of tighter environmental controls and market liberalisation and has prepared a strategic document entitled Agriculture 2020 which looks at population, GDP, use of wealth in addition to market and environmental trends. Policies are taken into account in these long term plans but not in day to day decisions (Interviews). *"...WTO and GATT affect world trade practices, we cannot affect world trade practices, our investment decisions don't affect that, and its unlikely that world trade practices...are sufficiently specific to affect our investment practices – its not a fine tool and investment decisions tend to be based on fine tools..."* (Senior Monsanto manager).

Thus, EU enlargement and WTO intervention are both considered in strategic thinking. Eastern Europe is considered a potentially large market and one perhaps more open to GM crops. Indeed more local policies, such as decisions made over Central and Eastern European countries' accession to the EU, would be much more likely to affect investment decisions (Interview).

One manager expressed concern over the broader impacts of market liberalisation. The number of small farmers who would be put out of business complicates the politics. This manager thought it unlikely that the Blair government would oversee the destruction of an estimated 80% of farmers, which the manager predicted would go under if full CAP reform were implemented.

Other regulatory issues were not mentioned as being significant in strategic or tactical thinking. One manager also stressed that in terms of decision making, the technological possibilities dominated.

In answer to a question about how long term projections are use and whether they impact on immediate R&D decisions, the manager said:

The simple answer is no. We have done the analysis of looking at...food, population, the interrelationship between food needs and population growth in different regions of the world, we have looked at specific regions and what the needs might be but the fact is that the controlling factors in the technology development are usually the technology issues themselves, how hard it is to transform a crop, how successful we are in being able to put a trait in a crop, do the fieldwork, assure ourselves that it's efficacy is there, that the safety is there....people always ask us, why did we go with BST as one of your first

products, well we did because that was one of the first pieces of technology development that came out, we could the transformation and the fermentation technology was there to produce the protein so we did it, we never dreamed that it would be as controversial as it was, but its been very successful from a commercial standpoint in the US (Senior Monsanto manager).

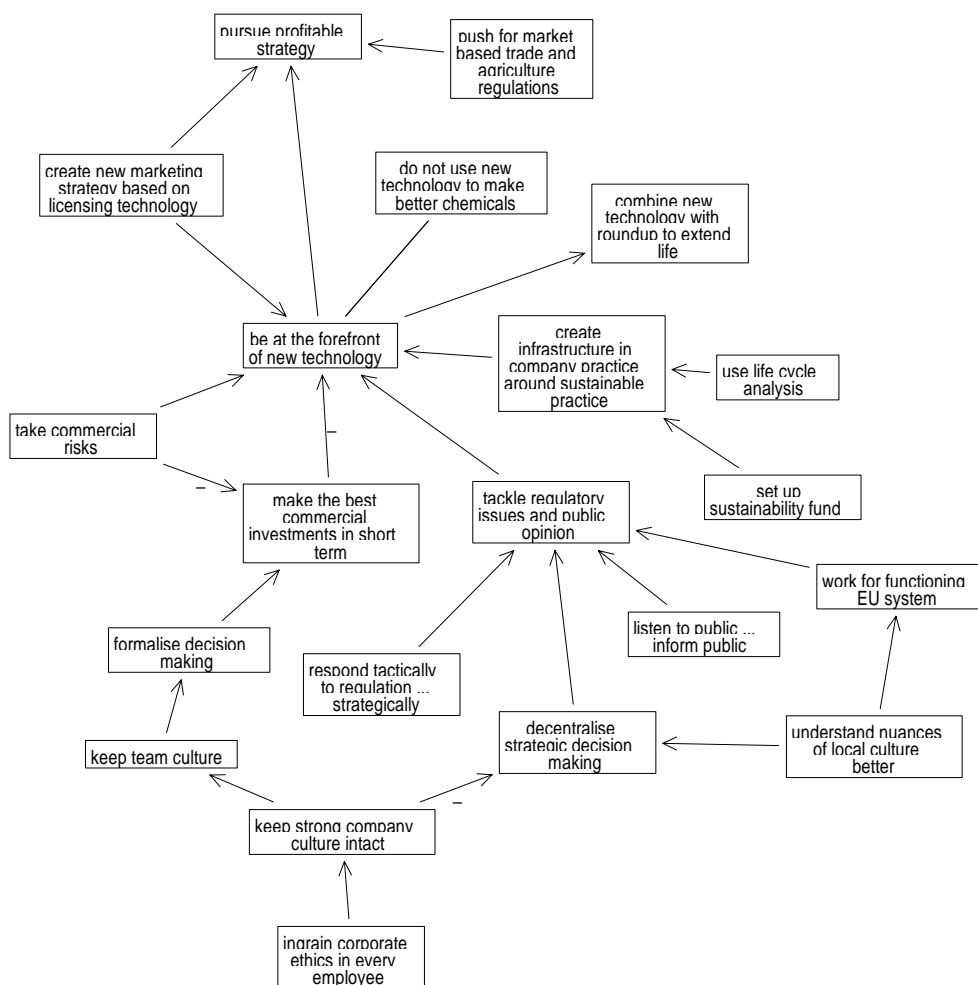
Going back to cognitive map 6, it is interesting to note that this manager thought that potential exists for governments to create a more conducive environment for innovation in more sustainable products and processes. This could be done by creating regulations that foster specific innovations. The constraint is thought to be that politicians are reluctant to raise taxes.

IPR regulation was mentioned as being generally important by managers but not as a specific component of policy which the company is currently responding to at the R&D level. Obviously patent and licensing disputes are very important aspects of Monsanto's day to day concerns.

7. Conclusions: An uncertain future

Monsanto's approach to agricultural innovation is summarised in the following cognitive map. Map 7 is based on interviews and other sources of information used in this monograph.

Map 7



The approach is being questioned by outsiders and in some respects by company managers. There are four primary areas of uncertainty: Commercial uncertainty; technical and environmental uncertainty; uncertainty about the way in which the company has dealt with non-farmer stakeholders; and uncertainty about regulation and public opinion.

7.1 Commercial uncertainty

Until very recently, Monsanto has been the accepted industry leader in biotechnology. It is a major player in the seeds industry and a significant presence in ag-chemicals primarily due to Roundup. Monsanto is in a paradoxical situation. Its current commercial sales for Roundup are high and the adoption rates for the new crops in the US have been good. Yet, forecasts are grim and stock values have plummeted. Even the company's assessments of itself reflect this and there is clearly a feeling that major changes will need to be made. (Monsanto New York Stock Exchange Quarterly Report, August 16 1999).

A major issue is future acceptance of new biotechnologies. Doubts have also been raised about the effectiveness of all products. For example, a USDA report called into question some company claims about reduced use of chemicals as a result of using herbicide resistant products (USDA, 1999). Monsanto's strategy is based on optimistic assumptions about growth in the GM plant and product market which less favourable reports suggest may not be realistic (HBS, 1997; HBS, 1996).

A worrying outlook was made worse with Deutsche Bank's advice to investors to sell shares in companies involved in the development of GMOs. Deutsche Bank warns that "growing negative sentiment" is creating problems for the leading companies, including Monsanto. Deutsche Bank's research report comments "We predict that GMOs, once perceived as a bull case for this sector, will now be perceived as a pariah" (Guardian, August 25 1999).

The company is heavily indebted and there are doubts about its survival. A merger with American Home Products (AHP) fell through in early 1999. Industry analysts close to Monsanto predicted throughout 1999 that without a successful merger the company would not have the market and product reach to weather current and short/medium term difficulties.

Latin America is a particularly key and vulnerable area. The most recent Stock Exchange Commission Report warns of economic difficulties in the region could cause serious problems. Ongoing disputes about Brazil's acceptance of GMOs must also pose a significant threat.

The company's share price fell from more than \$49 in March 1999 to less than \$34 in September 1999. It rose in November to over \$44. The rise was fuelled by disclosure that Monsanto had held talks on a restructuring with Novartis and Bayer (FT, Nov 11, 1999). Since then Novartis has confirmed a merger with the agricultural wing of Astra Zeneca. A report from the Bloomberg news agency on Nov 18th reported that Bayer and Monsanto were still in negotiations.

In late December, Monsanto announced a merger with Pharmacia and UpJohn. Initially, the plan was to retain all parts of the company. Within a day, however, the fall in share price of both companies, forced an announcement that the agriculture division would be sold off. The future for Monsanto Agriculture remains unclear. It now seems almost certain, however, that Monsanto will split its agricultural and pharmaceutical businesses, thereby ending the life sciences dream of CEO Robert Shapiro (Chicago, Bloomberg, Nov 19, 1999).

Monsanto is facing a very high degree of uncertainty in the immediate future. The principal uncertainty is to do with the agriculture division. Public opinion and regulatory structures are crucial to the company. Its immediate response has been to move towards further decentralisation in the hope that managers closer to the ground will prove more successful in winning over consumers and regulators. Observers continually raise the question of a continued presence in a hostile EU environment. Managers, however, are adamant that Europe is central to strategy.

The recent merger with UpJohn and Pharmacia promises more uncertainty for Monsanto agriculture. The stakes are very high. Monsanto's wholesale endorsement of a strategy

based on biotech and its widespread unpopularity perhaps means that the agriculture division may not easily find buyers.

One issue here is that Monsanto's innovation and marketing strategy has had the farmer at its core. Monsanto managers point to the dramatic sales figures as evidence of the success of this strategy. Yet, all managers interviewed were concerned about the way in which final consumers do not see the benefits of the new technology. Additionally, dominance of the seed market has fuelled antagonism toward the company amongst farmers. A report on the EPA-USDA June 18 1999 Bt-corn Resistance Management Workshop by Charles Benbrook highlighted farmer complaints.

"...Leon Corzine, an Illinois grower, stressed that farmers need to ask "Do I really need Bt corn?" He stated that many farmers in his area were forced to buy Bt-corn to get the best genetics suited to their soils and area. He said that the seed companies had farmers 'over a barrel' and that in his opinion, seed companies should offer all new varieties and genetics with and without Bt so that farmers would always be able to have a choice. Other farmer panelists made this same point during the day, raising one of the key issues that surfaced during the meeting..."

Farmers in the US have become increasingly hostile. Thus, the strategy of identifying farmers as primary stakeholders has backfired in two major ways. First, farmers seem to be reacting negatively to perceived attempts to pressure them into buying GM crops. They are clearly worried by the response to GM in Europe and by whether concrete technical and environmental problems with the crops are going to cause them other problems. Second, products have not appealed to final consumers.

7.2 Product uncertainty: Technical and environmental issues

A 1999 USDA report called into question some company claims about reduced use of chemicals and increased yield. Also, soya genetically modified to be resistant to glyphosate herbicide (produced by Monsanto) is less drought tolerant than the non-GM variety, while gluphosinate resistant soya (produced by AgrEvo) apparently does not suffer from this defect. The box below summarises some other controversies.

Roundup

EU: The European Commission has proposed to delay any decision to include glyphosate in Annex I of 91/414. As its rationale, 'after application for the intended uses and in the correct manner, harmful effects on arthropods... cannot be excluded', e.g. on several predators of insect pests (CEC, 1998).

Unrelated research in Sweden suggested links between glyphosate and non-Hodgkins lymphoma (Hardell et al., 1999).

Monsanto 'absolutely refuted' [denied] these claims. Environmental NGOs demanded an EU-wide ban (*The Guardian*, 13.10.99).

RR-soybeans

USA: Research suggested that RR-soybeans have lower nutritional value than conventional soybeans, due to lower levels of isoflavones (Niiler, 1999, citing Lappé in *Jnl Medicinal Foods*).

Yield losses

In hot weather the stems split open, resulting in crop losses of up to 40% yield. This effect is probably due to the 20% extra production of lignin, a side-effect of the metabolic pathway for glyphosate tolerance. The splitting could be a general problem in the southern USA and some Latin American climates (NS 20.11.99).

University study

Found 10-20% lower yield from Monsanto's gm soybean, compared to non-gm soya (Griffiths, 1999).

UW-Madison study

In 1998 Roundup-ready (RR) soybean varieties had an average 4-6% lower yield than conventional varieties, with wide variations between 86% and 113% of the conventional yield. There were just two areas where RR did better – Illinois and southern Michigan (Oplinger et al., 1999).

In 1998 seed-plus-weed costs represented 23% of variable costs, while now with RR-soybeans they represent 35-40%. It seems that the technology increased costs somewhat, but imposes a "price" farmers are willing to pay for the simplicity and robustness of the weed management system (Benbrook, 1999).

The company clearly has not managed to overcome concern about genetic engineering itself. A large advertising campaign in the UK failed and, from an industry perspective, worsened the situation resulting in a closer identification of the technology with an unpopular company.

7.3 Uncertainty about dealing with stakeholders

The company has been led from the US. It cultivated strong links with US politicians. In line with strong US leadership, an important component of Monsanto strategy has been its efforts to establish a very strong presence in key US agriculture markets.

Monsanto's style has provoked intense hostility and moves are now being made to change. Discussions with NGOs and the decision to halt work on the 'Terminator' gene are indicators of a new approach. The company is keen to portray itself as 'listening' as well as informing. However, there are no indications yet that this approach is having a significant impact.

Organisational decentralisation is also taking place with an emphasis on allowing non-US senior management more input into strategic decision making. The thinking here is that the company has to better understand cultural nuances and create more positive interactions with local stakeholders. It is unclear whether the type of changes underway will have a significant impact or how they will be affected by the recent merger.

7.4 Uncertainty about risk regulation and public perception

Monsanto took a leading role in arguing against risk regulation during the late eighties and much of the nineties. Although the company still calls for reform of the European system, the campaigning nature of these calls is not now evident. Whilst managers are reluctant to link the company's approach to risk regulation to anti-GMO sentiments, there is now clearly a feeling that high profile anti-regulation campaigns are not appropriate.

As with other chemical companies it is apparent that Monsanto lacks experience with, or adequate acknowledgement of, consumers and public opinion. Traditionally, final consumers have not been considered important stakeholders and the complexities of public opinion have not overly concerned strategists. It is possible that early decisions based on the defensive view that those who doubted the promise of biotechnology, or called for additional regulations, were all suspect, meant that opportunities to build constructive strategic alliances within the agro-food industries and with more supportive NGOs were not fully realised.

8. Impact of policy

The impression given in this monograph is that European and global level policy does not seem to have a major influence on R&D decisions or even on broader innovation decisions.

This is true to the extent that major R&D investments are made with long timescales in mind. There also does seem to be a gap between assessing trends in policy and pro-actively thinking about policy in terms of product development. There are some ways, however, in which policy impacts directly on decisions.

- Monsanto has looked at the global policy environment and at CAP reform and has decided that the basic framework of largely freely operating markets is stable. Plans and assumptions are based on this analysis.
- Risk regulation is clearly an important area which the company devotes a huge amount of time to trying to restructure. Efforts in the 1980s and most of the 1990s were primarily based on pushing for de-regulation. Now company policy is more pragmatic and conciliatory. The focus is on getting a workable system in place. Risk regulation policy, now to some extent driven by concerns of environmental groups, may yet have a significant impact on Monsanto policy.
- The company has realised it has to change the way it deals with stakeholders and that it cannot win the debate about biotechnology by being purely adversarial with policy makers and key special interest groups. Ironically this realisation may have come sooner if the risk regulators had taken a tougher stance during the 1980s and early 1990s.
- Monsanto's lack of engagement with policy at the EU level may be indicative of a larger issue in that it may reflect the lack of policy dialogue between EU policy makers and companies. In the US, the picture of Monsanto's engagement with policy makers would look different and this may be due to the way the that policy is discussed and formulated by policy makers as well as the fact that Monsanto is a US company.

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Trade press

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Other relevant sources indexed on those webpages include: *Business Economics*, *Chemistry & Industry*, *Barron's*, *The Economist*, *Euroweek*, *The Futurist*, *Investment Dealer's Digest (IDD)*, *Mergers & Acquisitions*, *Money*, *Pharmaceutical Executive*.

Other trade press not on the webpages: *Crop Protection Monthly (CPM)*, *Chemistry&Industry (C&I)*, *Fortune*.

Monsanto/primary documents

1997 Annual Report

1997 Report on Sustainable Development

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Achievements: Plant Biotechnology 1997

1998 Annual Report: Delivering on the Life Sciences Strategy

HybriTech: A Monsanto Company

Roundup ProBiactive: Product Information Guide

Avadex BW480

NewBioNews 1(1): Making the World's Food Better

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Appendix 1 Cognitive mapping technique

The technique of cognitive mapping is used throughout this monograph to present some of the information from interviews and also, in the overview section, to summarise the information from all interviews. The latter are labelled as summary maps to distinguish them from interview-based maps. When used to represent interview discussions, the maps follow the logic of the explanations given by interviewees. When used in the overview section, they represent our analytical interpretation of the company data.

Rules for developing and interpreting cognitive maps are as follows:

[Based on the Reference Manual for Decision Explorer Software, pp8-14, Banxia Software Limited, 141 St James Road, Glasgow G4 0LT.]

Concepts

Maps consist of concepts linked by arrows or lines. A concept is expressed as a short statement covering only a single idea or notion, for example assertions about components of a strategy, causes of a problem or means of improving a situation.

Concepts involve two contrasting parts, i.e. they are bi-polar. Thus, where there is '...' in the middle of a concept, this indicates X 'rather than' Y, as perceived by the person who made the statement (e.g. friendly ... distant). If the second pole of this relationship is not specified in a concept it implies 'X rather than not-X' (friendly ... not friendly).

Where concepts are numbered, the numbers are purely for identification purposes - they have no other significance.

Links

Links describe relationships between concepts. Along with the concepts, they form a line of argument, a description of a problem or the components of a strategy.

They can include a range of different types of relationship. The most usual are *causal*, *connotative* or *temporal*. However, *user-defined* links can also be added.

Causal links.

$A \rightarrow B$ indicates that concept A *leads to*, or *contributes to*, B or A *affects* B.

Connotative links

$A — B$ (i.e. a simple line, no arrow) implies that the two concepts are associated in an unspecified way.

Temporal links

$A \rightarrow B$ (with a letter 'T' attached to the arrow) implies that B follows in time from A.

Positive and negative links

Unless specified otherwise, links are assumed to be positive, i.e. the first pole of one concept leads to the first pole of the linked concept. Where a negative sign is attached to an arrow this indicates that the first pole of one concept leads to the second pole of the consequential concept. These conventions do not apply to connotative links.

Appendix II Patents, licenses and related disputes.

Herbicides: agreements with US competitors

The Roundup patent continues only in the USA and will lapse there in the year 2000.

In 1998 Monsanto gained EPA approval for RoundupUltra to be sprayed on RR-maize and soya.

To protect its US herbicide markets from generic competition, Monsanto has devised extra measures, e.g. a price reduction in late 1998, and licence agreements with other firms:

Dow: agreement for Monsanto to produce glyphosate (using materials from Dow) and to supply Dow, which will be entitled to use Monsanto's registration data for its own formulations. Dow is entitled to market the herbicides for use on RR soybeans and cotton from the year 2000, and on RR maize from 2001.

Other companies (Novartis, Cheminova, MicroFlo/BASF) are discussing similar arrangements.

Zeneca is an exception, because it had already invested in registration of its own proprietary glyphosate salt (see litigation below).

Other herbicides

Rhône-Poulenc: 1997 agreement for RP's *Balance* (isoxaflutole) to be combined with Monsanto's *Harness* (based on acetanilide, related to alachlor, used on maize) in premixture.

Anti-trust & patent licence measures

Monsanto's recent acquisitions would give it substantial sales of key seeds in the USA, as follows (Hayenga, 1998).

	1997	1998
soybeans	20%	25%
cotton	84%	87%
corn market	14%*	

(* plus Holden's sells germplasm to other companies and supplies 1/4 of US maize seeds)

The US Dept of Justice accepted Monsanto's purchase of DeKalb by imposing anti-trust conditions, which led to the following commitments (not all specified by the DoJ):

the Roundup-Ready gene will be licensed to any company wanting to use it;

patent rights to the *Agrobacterium*-mediated gm maize technique will be transferred to UC Berkeley, which in turn may sub-licence; however, this patent anyway is subject to two accusations that it infringes other patents;

Holden's corn germplasm will be licensed to other seed companies; Holden's customers may back-cross gm traits (developed by third parties) into Holden's lines for 7 years; and

Stoneville, the cotton-seed part of De Kalb, will be sold off (see below).

Monsanto has tried to use some constraints as opportunities, e.g. by setting terms which encourage Roundup sales.

Patents&licences on crop&genes (mainly from Hayenga, 1998)

Monsanto has offered seed companies a financial incentive for boosting sales of crops which contain its gene, e.g. if they reach 2% of sales by 2000 and 85% of all herbicide-tolerant sales by 2002.

Monsanto has protected the income from its patents (e.g. on Roundup-Ready and Bt genes) by various means:

breadth: claimed broad patents, to deter competitors from entering entire crop ranges;

licence agreements: as means to gain revenue while minimizing competition and litigation;

no 'stacking': other companies may not stack Monsanto's RR gene with their other genes;

farmers' contracts: growers undertake not to save seed for re-sowing or selling, and to use only Roundup herbicides on RR-crops.

Agreements not concluded

In October 1997 Pioneer Hi-Bred decided not to include Monsanto's RR gene in its seed corn, on grounds that Monsanto's restrictions and high charges would outweigh the benefits to farmers.

According to Monsanto:

'Licensing provides an additional means of delivering value to growers from our biotechnology traits. We continue to license our traits to more than 200 independent seed companies...' (AR 1998: 13). The company marketed more than 10 biotech-related plant sciences products during 1998 with its licensing partners, e.g. Bt and RR-crops (AR 1998: 34).

Litigation by/against Monsanto

Litigation on crops & genes

Among biotech companies, Monsanto is probably the most litigated company, e.g.:

Successful surveillance/litigation against farmers for infringement of contracts, regarding saved seed.

Successfully defended its Bt technology as not infringing Novartis' broad patent, which had claimed exclusive use of Bt in corn.

Unsuccessfully accused Novartis and Mycogen of infringing its Bt patent.

Unsuccessfully refused to licence its RR and Bt genes to Mycogen, which was awarded \$172m damages from Monsanto, which in turn has appealed.

Unsuccessfully defended use of a RR gene sublicenced from De Kalb, in turn licenced from Rhône-Poulenc before Monsanto bought De Kalb. Rhône-Poulenc argued that De Kalb was not entitled to transfer the gene to another company. A jury ruled that DeKalb had breached its agreement with R-P; the decision will pave the way for a further R-P action against Monsanto for patent infringement and trade-secret misappropriation (CPM 30.04.99).

Settled in the case of Cargill's international seed business inappropriately using Pioneer's germplasm which had been acquired before the Monsanto purchase (CMR, 15.02.99).

Litigation relevant to glyphosate/Roundup

Background: Zeneca has registered its proprietary glyphosate salt herbicide, *Touchdown*. In 1997 Zeneca terminated a glyphosate supply agreement with Monsanto and began producing its own glyphosate in the UK (CW, 12.08.98).

Monsanto accused Pioneer of allowing use of Monsanto's RR soybeans by Zeneca for testing *Touchdown* – as a patent infringement.

Zeneca in turn sued Monsanto to establish its right to sell *Touchdown* for use on RR crops, contrary to Monsanto licences which prohibit farmers from using alternatives to Roundup.

Litigation was ended by a settlement: Monsanto licences Zeneca to sell *Touchdown*, in return for a fee – called 'modest' by Zeneca, though not by Monsanto (FT, 13.03.99). Analysts

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suggest that Zeneca may have to offer farmers a reduced price for Touchdown in order to compete with Roundup.

Monsanto's acquisitions and gm crops

crop	germplasm	agronomic traits		disease-resist	consumer traits	
		herbic-tol	Bt*		quality	sales by
					Calgene (many traits)	Cargill (all crops?)
soybean	Asgrow, FLS	RR	<i>RR/Bt 2002?</i>		hi-stearate 2000?	
potato	PBIC	<i>2002?</i>	NewLeaf	NewLeaf+ (VirusY)		
maize	Holden's, SA, Cargill	RR	YieldGard 2000?*	yes	<i>lo-phytate high-oil</i>	SA
cotton	Calgene, DPL, Mahyco	RR,	Bollgard 2000?* BXN**			Mahyco
OSR	Cargill, PBIC	RR	<i>2000?</i>		Laurical; hi-stearate, 2000?	
tomato	Calgene		<i>2001?</i>	yes	FlavrSavr	
squash	Asgrow			Freedom II		
wheat	HybriTech, PBIC			yes		
sunflower	Cargill					

Table lists products in commercial use or *in development (in italics)*. yes = being developed, among others

The year is Monsanto's prediction for the product launch (*AR 1998: 22-23; also AR 1997: 24-26*).

* A second-generation of Bt genes is being designed to minimize the development of resistant insects by using a different mode of action, esp. for Bollgard. [AgrEvo has already marketed such a Bt maize product in the USA.] A third-generation of Bt maize protects the crop from rootworm.

** BXN: Rhône-Poulenc's cotton combines its bromoxynil-tolerance gene with Monsanto's Bt gene

Company abbreviations

FLS: First Line Seeds (Canada)

DPL: Delta & Pine Land

Mahyco : Maharashtra Hybrid Seed Company (India)

PBIC: Plant Breeding International-Cambridge(UK)

SA: Sementes Agrocere (Brasil)

GM maize: agrochemical reductions and yield increases

After many years of speculative arguments on these issues, as well as quantitative claims from Monsanto and industry-funded sources (see main dossier), independent studies in North America provided some data on gm maize, cotton and potatoes; these data fuelled further debate. The figures below focus on maize, for its greater relevance to Europe (since little soybean or cotton is cultivated there). The reports showed variations in results across

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regions and years. For Bt maize in particular: Unlike reliance on chemical insecticides, gm seed requires farmers to pay a premium in advance, without knowing whether they otherwise would have incurred yield losses; pest infestations are unpredictable from year to year.

ERS study: Bt and herbicide-tolerant maize (USDA/ERS, 1999)

Yield increased in 11 of 35 region-year combinations over three years, especially for Bt maize; yield increases were rare with herbicide-tolerant maize.

Pesticide usage was similar for gm/non-gm maize overall.

Somewhat increased revenues and lowered herbicide costs did not compensate for the higher seed costs and technology fees paid by farmers.

U-Missouri study: Bt maize (Rose, 1999)

Bt hybrids yield comparably to non-Bt hybrids, though lack of pressure from the ECB made Bt hybrids less profitable in Missouri this year. 'Corn borer pressure is at a 10-year low in much of the Corn Belt, even in places where it is usually found.'

Iowa State-U study: Bt maize (AP, 1999)

Study shows that farmers in the Midwest who planted Bt corn in 1996-1998 reduced their insecticide use each year: 26% of the farmers in 1998, 19% in 1997, and 13% in 1996. About half of the Bt-corn farmers surveyed said they don't use insecticides. [Presumably this means that they never did use insecticides; nationally, over half never did so.]